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Chicago Academy of Sciences

THE LICHEN-FLORA

OF

CHICAGO AND VICINITY

BY

WILLIAM WIRT CALKINS

BULLETIN No. 1

OF THE

Geological and Natural History Survey

ISSUED APRIL, 1896

LETTER OF TRANSMITTAL.

CHICAGO, ILLINOIS, April 1st, 1896.

DEAR SIR:

By direction of the Board of Managers of the Geological and Natural History Survey of The Chicago Academy of Sciences, I herewith submit to you the report on The Lichen-Flora of Chicago and Vicinity, prepared by William Wirt Calkins, for publication as Bulletin No. 1 of the Survey, to be issued under the rules of the Academy governing such matters.

Respectfully,

C. M. HIGGINSON,
Pres't of The Academy of Sciences.

WILLIAM K. HIGLEY,
Chairman.

General

The Board of Managers of the Geological and Natural History Survey of The Chicago Academy of Sciences:

WILLIAM K. HIGLEY, Chairman.
CHARLES S. RADDIN, Secretary.
GAYTON A. DOUGLASS.
WILLIAM E. LONGLEY.
THOMAS L. JOHNSTON.

THE GEOLOGICAL SURVEY.

The BULLETIN on the Lichen-Flora is the initial number of a series of publications in which the Geological and Natural History Survey of the Chicago Academy of Sciences proposes to discuss the plants, animals and geological formations found in the vicinity of Chicago. In this first issue it may be well to briefly outline the history and state the objects and aims of the survey.

On the 10th day of May, 1892, the Academy of Sciences unanimously adopted the recommendation of its Executive Board that a committee of three be appointed from its active membership to conduct a topographical survey of Chicago and vicinity. At the June meeting of 1892 the Academy adopted the recommendation of this committee to enlarge the scope of the work so as to embrace the natural history of the region; the work to be known as the Geological and Natural History Survey of the Chicago Academy of Sciences. Three general departments were decided upon: Geology and allied sciences, Topography, Zoology and Botany. It was further decided that the work in the several divisions of these departments should be entrusted to men recognized as specialists, and published as bulletins and reports, which should be as nearly monographic as possible.

Since the organization of the survey, the work has been steadily progressing, and a large amount of data has been collected. It is eminently fitting that before studying the rocks and higher forms of vegetable life, the lichens should be taken from the boulders and the bark and made the subject of the first issue.

The survey comprises a labor both of economic and scientific value. The publications on geology and topography are awaited with great interest by contractors, engineers and scientific men generally. The co operation of practical men in the preparation of these reports has been spontaneous and very general. It is proposed to show the character of the rock strata underlying our area, their distance from the surface in different localities, the nature of the materials resting on the rock, the depth necessary to reach water, and such general information as will assist builders, well-borers and engineers in the prosecution of their professions. With this will be reports on the geological formations, their origins, extent and relations to the present condition of affairs in Chicago and vicinity. There are many features of our local fauna and flora which are either unfamiliar or unknown to the majority of the people. Hence to place reliable reports on these subjects in the hand of older workers and beginners, of educators and students, is not only to increase facilities for information, but to awaken interest and stimulate investigation.

The area covered by the survey is peculiar in two distinct systems of drainage, either of which may, under certain conditions, prevail over the other. This peculiarity of the drainage is of great scientific interest. To bring out this relief it was thought desirable to fix upon the following boundaries: Beginning at the north line of Cook County and Lake Michigan, thence westward, coincident with the north line of Cook County to Kane County; thence southward along the east line of Kane and Kendall Counties to the southeast corner of Kendall County; thence eastward, coincident with the south line of Cook County to the east line of Lake County, Indiana; thence northward to Lake Michigan.

This gives an area of about forty-eight or fifty miles square, which, after deducting the approximate area of the lake-covered portions, leaves nearly eighteen hundred square miles of land surface. It comprises all of Cook and DuPage Counties, the nine north townships of Will County and a portion of Lake County, Indiana. Of the proposed reports now in preparation, a list of which may be found elsewhere, many will be illustrated and some will describe species. All will give such notes and information as will be of scientific interest.

It will be the aim of the Board of Managers of the survey to have specimens in the Academy collection illustrating the local rocks, minerals, fossils, animals and plants enumerated in the reports. This will enable the student to compare and study the objects and not have to depend solely on descriptions.

The first BULLETIN, on the Lichens, is of especial value, because the field is practically new in our vicinity. Few of our local botanists have directed their attention to this class of plants. Mr. Calkins has deposited a complete collection of local lichens in the Herbarium of the Academy building, and it is hoped that the BULLETIN, together with the specimens, will develop interest and investigation in this form of plant life, and lead to the discovery of many new species and localities. It is desired that all who are interested in the advancement of science will co-operate with the Board of Managers by furnishing any data within their reach.

The Lichen-Flora of Chicago and Vicinity.

WILLIAM WIRT CALKINS.

INTRODUCTION.

The following report, based upon my personal investigations, collections and studies, during a period of many years, has been prepared by invitation of the Board of Managers of the Geological and Natural History Survey of The Chicago Academy of Sciences.

As directed by the Board the report covers an area comprising all of Cook and Du Page Counties, nine townships in the northwest part of Will County, and a portion of Lake County, Indiana. This territory might be thought sufficiently large to furnish an attractive field and ample material for the investigation and study of lichens, yet with the exception of the most common species, a few of which are cosmopolitan in their habits, the explorer will meet with a disappointment not to be experienced further south and west in regions where the conditions of the soil, the geological features of the country, and the climate favor a larger development of species. Hence mountainous districts and the extreme South offer the greatest variety of forms, those of Florida being largely semi-tropical and identical with West Indian and Central American species, especially in certain genera, as Graphis and Arthonia. However, in the field under our consideration, enough varieties occur to form an excellent preliminary course of study, fitting the student for larger views and greater results when he has become familiar with the Parmelias and Physcias which are so abundant on oaks and other trees along the lake shore and in the "wooded islands of the prairies."

The geological conditions in most of our territory are not favorable to the growth of a great number of species owing to the absence of forests and out-cropping rocks of different formations and ages, all having an important bearing, because these are the substrates to which lichens attach themselves, and the investigator will note at once that certain strata and trees, or the earth, contain some species not found elsewhere, while others are indifferent as to substrate. Localities in and around Chicago formerly rich in lichenose vegetation are now destitute of it. The species were and are mostly corticolous, with a few on rocks, where exposed, and even on the boulders of our prairies. But the tidal waves of civilization have changed the conditions under which lichens grow, and to find them abundantly we must seek the country where the air on which they feed is pure and the substrates suitable. The sandy soil of the lake shore only produces them where it is covered or mixed with vegetable mould. Northwards from the limits of Chicago the genera Cladonia and Peltigera are found in the woods on earth. The scarce growth of Birch (Betula papyracea), near Glencoe, contains two species rare in this section. These are Sagedia oxyspora, Tuckerm. and Pyrenula thelæna, Tuckerm. The former is peculiar to that substrate. On trees, notably the oaks, are abundant growths of Parmelia borreri, Turner, P. caperata, (L.) Ach., Physcia stellaris, L., Lecanora subfusca, Ach.; and on hickory, Arthonia lecideella, Nyl. The latter is peculiar to this substrate and the genus rare, in our territory, in species, although the above and A. spectabilis, Fl., are abundant. Leaving the vicinity of the lake and the flat-prairies, we find further west and south the best development of lichen-flora along wooded streams and on rocks where these are exposed. Gravel, boulders, old fences, logs and stumps, sustain many species. New and rare ones sometimes reward the explorer. At Riverside I found a new Verrucaria on siliceous deposits and at Joliet, another new species, Lecanora perproxima, Nyl., on silurian rocks. Both have been described by Dr. Nylander, of Paris. The saxicolous species are the most difficult and many are in confusion. The occupation and use of nearly all the lands; the denudation of forests, and drainage of the country, has, as in the case of the phænogamia, caused many species to disappear entirely from our territory. The best localities for saxicolous types are in the township of Lemont and Will County. Hanover and other places adjacent to streams produce common forms. A few occur on earth and on mosses, which are minute and easily escape detection. On calcareous soils in Lemont, also in Will County, may be found, besides Cladonia, the curious Heppia despreauxii, Tuckerm. and several species of Endocarpon; also a member of the Algæ Nostoc commune, L. The close association of these species, which I have witnessed in other States on similar strata, is worthy of note. From what has been said it appears that it is not safe to fix definitely the number or limits of species in any territory, at this early date of scientific research. The experience of the author, resulting in the addition of nearly thirty new species of lichens to botanical science, is proof of the fact that there are still hundreds of species yet undiscovered.

Some eight years ago Willey estimated that the whole number of North American species might ultimately reach one thousand, but that limit has been passed already, as I have the names of over sixteen hundred, including varieties, and it is not at all probable that, after the most conservative study and elimination, the number would be reduced by more than three hundred, if so many.

Having now reviewed in a general way the lichen-flora of the territory under consideration, it seems proper, as nothing has ever been published in the West and South regarding Lichens, beyond mere lists of species, that something should be said about the life history of these humble plants, and of the study, development and progress of the Science of Lichenology, especially in the United States. The account must necessarily be condensed, but it is believed will be of great utility.

WHAT ARE LICHENS ?

This very natural and primary question may be thus answered: Lichens are a natural order of aerial plants which are considered as intermediate between Algæ and Fungi, but the limits are still uncertain. All are Thallophytes destitute of stem, leaf, root, or flower, and vegetate under the influence of moisture, obtaining the elements necessary to their growth from the air, and not from their substrates, as do the Fungi. Consequently lichens are rapid or slow in growth according to the conditions surrounding them. In extreme heat they become torpid, or do not fully develop, frequently appearing on the surface of their substrates as excrescences, wart-like or coralloid. This condition gave rise to the pseudo-genus Lepraria, Isidium, etc., not now recognized. Lichens may grow for a century or more, and under poor surroundings increase by bisection, like Algæ. They will be found under these conditions near towns and cities, where the air is not pure.

The thallus and the apothecium, or fruit, are the parts of the plant to first attract attention in the higher lichens—for example, the Parmelias, so common on our oaks. The thallus is attached to its substrate by fibrils, or is subcortical, but is absent in certain species, as the parasitic ones.

In the thallus are green cells called gonidia, and other organs, as spermogonia and pycnidia. Dr. T. M. Fries constructed a system based on the gonidia, which are variously formed and colored. The thallus supports the apothecium, which is the most important part of the plant. This appears on the surface, disk-like, lirellate, etc., and of several colors, such as red, orange, black or brown. In some genera the fruit appears as minute, wart-like bodies, with only a pore (ostiole at the summit. In others, as Cladonia, the fruit is at the end of thalline stalks (podetia), or as in Cetraria, on the edges of the thallus. There are, however, various modifications of all these. One peculiarity of some lichens is the power they have to burrow into the hardest rocks, even flint and granite, thus making for themselves homes (foveoli). The power is furnished by the carbonic acid absorbed from the air. As an example, Verrucaria ruderella, Nyl., from the limestones of La Salle county, Ill., may be mentioned. The apothecium contains the germinating cells, or spores, which are inclosed in sacks, called thekes. There are many organs, all of which must be examined under the microscope, and these have been the subject of profound study and discussion many years, but especially since the microscope came into use. On them many fanciful theories as to the origin of lichens, whether they are autonomous or not, have been built. Fries called them aerial algæ. Schwendener gives his views as follows, which seems marvelous, if true: "All these plants are not individuals in the common sense of the term; they are rather colonies, consisting of hundreds of thousands of individuals, of which one holds the mastership, while the others, in eternal captivity, prepare the nourishment for themselves and their master. The master is a Fungus of the class of Ascomycetæ, a parasite which lives on the labor of others. It encloses them as a spider its prey, with a network of delicate tissue, which is gradually transformed into an impervious integument. But while the spider sucks the life out of its prey, the Fungus stimulates the algæ in its grasp to greater activity, to a more vigorous increase, and thereby renders possible a more luxurious growth, and promotes the welfare of the whole colony." *

However grand the Schwendener theory, the question of autonomy is still open, while new discoveries are being made which may eventually change the whole aspect of the science. Our best way now is to effect their classification under the present system as elucidated by Tuckerman, but not ignoring others entirely.

The student seeking to become acquainted with lichens will soon learn to distinguish those highest in the scale, as Parmelia and Physcia, in our vicinity, by the prominent, foliaceous thallus, and apothecium, and having fixed the external character in his mind, will soon associate with them others of similar appearance, yet differing to some extent in thallus and fruit. In the same manner he will identify and bring together species of other genera, and perhaps stumbling on forms of Lecanora and Pyrenula, lower in the scale, observe the characters that seem prominent and common to all. Experience will enable him to determine very many of our common species from external characters alone, as indeed, the early lichenologists determined them all, even up to the time of Webber and Acharius.

THE DIVISIONS OF LICHENS.

All our lichens may be placed in one of the two series into which they are divided by the fruit. First, the Gymnocarpi, those with open fruit; second, the Angiocarpi, those with closed fruit Pyrenocarpous). There are five tribes, Parmeliacei, Lecideacei, Graphidacei, Caliciacei, Verrucariacei. Only the last belongs to the second series. The tribes are based on the apothecia; families on the thallus and fruit. Genera and species follow. Other subdivisions are made for convenience, and sometimes at the caprice of authors.

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* *Die Algentypn Flechtengonidien.*

THE THALLUS AND APOTHECIUM—SOME OF THEIR ORGANS.

The thallus, when present, and the apothecium, are to be considered and studied externally, but the organs of the plant must be examined with the microscope. Some of these have been mentioned, and I can only refer briefly to others, doing so in order to guide the first steps of the explorer, who, at every advance, will meet with new problems and find all aids necessary. In examination, the membraneous thallus, cut in a thin section, will show above what is known as the cortical layer of minute aggregated cellules; next, the gonidial layer of green cells; then will follow compacted filaments (hyphæ), and in this formation rest the gonidia. Below is the inferior cortical layer, from which, in many species, proceed fibrils (hypothallus), attaching the plant to its substrate. Some lichens, such as the parasitic, and some others, Peltigera and Collema, have no thallus; either the upper or lower cortical layer may be absent, or but one scantily represented. The gonidial and other wart-like eruptions sometimes appearing on the crust (soredia), constituted the basis of the old pseudo-genera. The color of the thallus above and below may differ, as in Sticta. The gonidia of divers forms and colors are variously placed, singly or grouped, or of confervæ-like character.*

The apothecium, which has been slightly noticed, whatever its shape, has a uniformity of internal structure. The disk-epithecium, (exciple), contains the other organs, and is enclosed by a margin, which may be formed from the thallus (thalline margin). It is then known as lecanorine. When the margin or border is not thalline the apothecium is lecideine. Then there is the nuceliform apothecium of angiocarpous lichens. The exciple, when colored or blackened, is biatorine; when composite, zeorine. Grouped apothecia form a stroma. The perithecium and amphithecium of the angiocarpous lichens are the outer and inner coverings; within is the nucleus. A section of the apothecium viewed under the lens, shows the epithecium to be of colored, granular matter and borne on the apices of what are termed the paraphyses—slender filaments growing from the medullary layer. The apices are globular or clavate. The thalline exciple containing gonidia, and the hymenium, bearing the thekes, within which are the spores, will be seen. The hymenium is either colored or colorless. The thekes vary in shape, linear, clavate, etc., and are large or small, according to the spores. The latter are variable in form, size and color, as well as in number; they are either simple or divided by transverse septa into cells, usually eight, when they are called eight-locular; if more, pluri or multi localar, but there may be less. When it is also divided longitudinally it is called a muriform spore. The examiner will often find no spores, hence should have fresh plants, particularly of Arthonia. The spore may be less than a thousandth of a millimetre in diameter, but some can be seen with an ordinary lens. Much importance is attached to the colors and shape of the spores. Spermagones have been mentioned. These will exhibit, arising from them, small filaments, which if simple are called sterigmata; if articulate, arthrosterigmata, to which are attached minute bodies (spermatia) which are various in form. Nylander, Minks and others have theorized and written learnedly in regard to their functions.

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*Th. M. Fries, Dr. Minks and others as to their systematic value.

It would be desirable to explain further in regard to the spores and other organs entering into lichens, but these can be studied to better advantage after one has acquired some knowledge of the more obvious characters, besides no one can do much with any satisfaction until he has studied our greatest American authority, Tuckerman, and with his works those of the great Lichenologists of Europe, a few of whom are mentioned hereafter. Armed with these, a genuine love and adaptability, success is assured up to a limit, for it is not probable that all the secret processes of nature can be wrested from her grasp by even the greatest minds in a single lifetime.

THE DEVELOPMENT AND PROGRESS OF THE SCIENCE OF LICHENOLOGY.

The study of lichens was for many years, on account of its supposed difficulties, confined in this country to a very few persons, who lived remote from each other. Thus it has a scattered and little known literature, which, however meager in quantity and quality (with the exception of the works of Tuckerman and Willey), has proved almost inaccessible to students, or those who otherwise would have become interested in a branch of botany now assuming more importance among American students. There were, also, other reasons why so few botanists pursued the study. Until the late Professor Edward Tuckerman published his great works upon American Lichens, the results of a life-time of devoted labor, there was not in the United States any lichenological literature worthy of the name; no system of classification of American origin, under which our vast and rich lichen-flora could be arranged. Students were dependent entirely upon the works of Euporean authors, and these were mostly in foreign languages not easily to be obtained or understood here, except by the very few, who, like Tuckerman, lived under the shadow of a great university and had a liberal education. Thus it was that New England almost wholly absorbed the study of this branch of science. Also, every European lichenologist had a system of his own, and no two could agree on a uniform method of classification applicable to the species known and the many new forms being constantly discovered.

In ancient times nothing was known of lichens as a distinct order of plants, but one or two species have been found in coffins, no doubt used for padding. A reference to the old herbalists of the twelfth and fifteenth centuries show that lichens then went under the names of "fuscus" or "muscus," and were considered allied to the mosses. They began to attract more attention in the sixteenth century, and over twenty species were described. The general revival of all learning after the dark, middle ages, stimulated the study of botany, and lichens shared in the benefit. It was then that Tournefort separated them from the musci, and included all then known under the general name, Lichens. This distinctive term was accepted and used by the great Linnaeus. From sixteen hundred to the Acharian period, about 1802, rapid progress was made in the study. During this period lived Micheli, Webber, Dillenius, of Oxford, Hoffman, Linnæus and Acharius, the "Father of Lichenology." All these were celebrated for their learning and published works upon lichens. Over three hundred species became known up to 1750, and were arranged in natural groups and genera, many of which still stand. Their chemistry and economic uses were studied, and collections of lichens made. But the best thoughts of investigators in the latter part of the eighteenth and the first years of the nineteenth century found a truer expression at last in 1803, when Acharius published the result of his studies in the Methodus Lichenum, followed in 1810 by his Lichenographia Universalis, and in 1814 by the Synopsis Lichenum. These gave full accounts of all the then known species, over nine hundred. A number of American species are mentioned.

He made no use of the spores and thekes in his classification. The system he founded was long used and made his name immortal. In 1831, Elias Fries, the great Swedish botanist, published the Lichenographia Europea Reformata, and gave utterance to views that have influenced all later studies of the greatest students of lichens. He divided them into eight tribes, of which five now stand as given elsewhere. He also made further divisions which subsequent writers changed or assumed. The views of Fries were so far in advance of others and his work as a systematist so highly regarded, that Tuckerman referring to the advances made in the study of lichens, says: "The whole movement took its start from the results gained by the unsurpassed penetration of Elias Fries."

But the period was a golden one and prolific of eminent botanists—Nylander, Eschweiler, Fee, Wallroth, Schaerer, Montagne and Floerke, all systematists. There were also many others of great eminence in Lichenology. Of the above Dr. William Nylander, who still survives, is the most celebrated. He has not only published many philosophic papers and works, but has described more new species than any other man, and his knowledge of lichens exceeds that of all others. Dr. J. Muller is hardly less distinguished, however, while Dr. Minks, and Schwendener, have achieved renown by wonderful discoveries as to the anatomy and growth of lichens, which, if they are confirmed, will overturn all previous theories. From what has been stated it will be seen that Europe had monopolized the field of study, and naturally enough, for America was young.

It was at such a time that Tuckerman, who had turned early to the investigation of lichens, became an earnest student of the great European botanists, particularly of Acharius, Fries and Nylander. Assisted in the field by several enthusiastic workers, portions of New England were explored and the lichen-flora studied and made known to the world. As his views enlarged he gradually came to have conclusions of his own as to the systematic arrangement of the species in harmonious and natural relations with each other. The great Swede seems to have been his guide in part, while Nylander was not disregarded, nor in later years the new discoveries of Minks, Tulasne, Bayerhoffer and others. Tuckerman was pre-eminent as a systematist, and the full elucidation of his views will be found in his works—The Lichens of California, 1866; General Lichenum, 1872; and his Synopsis, Part I., 1882. A close study of these will show how very near he came to nature in his reading of her laws as applied to the lichens, and how well he succeeded when he came to their arrangement. The key to his success may be found in his expression—"Apprehension of the Habit of Lichens." This was certainly an inspired faculty and led him to forecast the relations of lichens by which they could be placed in the system he established, as Tribes, Families, Groups, Genera, Species, etc. The one great American Lichenologist is dead, but the services performed cannot be overestimated. Part II. of his Synopsis, left incomplete at his death, which occurred March 15, 1886, was edited and published by Henry Willey, Tuckerman's life-long collaborator, in 1888. The foregoing were by no means all of Tuckerman's works, but they are the most important, on which rests the solid basis of his fame. As a supplement to the labors of Tuckerman, American Lichenology has been benefitted by Henry Willey, in his publication, "Synopsis of the Genus Arthonia," and his introduction to the "Study of Lichens," but these must be considered rather as aids to be used in connection with the study of other authors. While the publications mentioned are the chief ones in this country, monographs upon a single genus, or species, have appeared from time to time; also local lists and brief papers, and these evince the interest awakened, which no doubt received its impelling force from a knowledge of the genius and labors of Tuckerman.

THE ECONOMIC USES OF LICHENS.

A few remarks on this subject will show how large a part these seemingly humble plants play in the economy of life. The Reindeer Moss (Cladonia rangiferina) furnishes not only food for the reindeer in the Arctic regions, but alcohol and brandy are distilled from it by the natives of Norway, Sweden and other countries. The Iceland Moss (Cetraria Islandica) has long been in use, both for food and medicine. Cetraria nivalis is also eaten. In Africa Lecanora esculenta is so abundant on sandy plains that it is gathered for food for man and beast. Many Arctic voyagers have prolonged and saved their lives by the use of species of Umbilicaria—rock-lichens (*Tripe de roche*). In Japan a species of the genus Endocarpon,, also common in Illinois, is used as food. Valuable dyes were formerly obtained from several lichens, such as Roccella tinctoria, Lecanora tartaraea, Parmelias, etc. The new discoveries in chemistry did away with their use in civilized nations. Lichens were once valued highly as remedies for various diseases, and some species are still used, as Peltigera canina. Theloschistes parietinus, Cladonia aphthosa, and numerous other forms of various genera, all common to our own country and easy of investigation by students.

LICHENS OF THE TERRITORY INCLUDED IN THE SURVEY.

The species enumerated are represented in the "Exsiccati of North American Lichens," deposited in the collection of the Chicago Academy of Sciences by the author. The descriptions of species are made from studies of the specimens, comparisons, and study of other authors.

SERIES 1. GYMNOCARPI.

TRIBE 1. PARMELIACEI.

FAMILY 1. USNEEI.

Ramalina, (Ach.) De Not. Thallus fruticulose, or pendulous, subcompressed, pale-greenish; apothecia scattered, or marginal, scutellæform. Spores colorless, bilocular.

1. **R. calicaris,** (L.) Fr. Thallus tufted, rather rigid; longitudinally lacunose; apothecia flattish. Spores ellipsoid.
On oaks near Riverside; at Lemont on stony bluff, and in Will County.

2. **R. calicaris,** Fr., var. **fraxinea,** Fr. Thallus wide and long-lobed; apothecia lateral.
On oaks and old fences near Lemont.

3. **R. calicaris,** Fr., var. **fastigiata,** Fr. Lobes short, often straw-colored, crowded, branched; apothecia terminal, subfastigiate.
Along lake shore and throughout our territory, on oaks.

Cetraria, (Ach.) Fr., Mull. Thallus ascendant with compressed, turgid, or channelled branches; or may be expanded and foliaceous-membranaceous; brown, yellowish, or glaucescent; apothecia marginal or submarginal, scutellæform, often dilate. Spores sub-ellipsoid.

4. **C. ciliaris,** (Ach.) Thallus membranaceous, foliaceous, sinuate-laciniate; greenish or brownish; brownish beneath, fibrillose; lobes crowded, often narrowed and cleft, lacunose; apothecia marginal, ample; disk chestnut, margin crenulate. Spores subellipsoid. Ach. L. U., p 508. Platisma, Nyl. 5, Syn. 308.
On old rails in Lemont Township; on old birch at Glencoe.

5. **C. aleurites,** (Ach.) Th. Fr. Thallus membranaceous, foliaceous, divided or cleft, isidiod, plicate at centre; beneath pale, wrinkled, fibrillose; lobes sinuate-laciniate, with crenate tips; apothecia marginal, granulate on the margin, brown, medium size. Spores round.
On old rails near Lemont and Joliet.

FAMILY 2. PARMELIEI.

Theloschistes, Norm. (Physcia, Nyl.) Thallus foliaceous or reduced, appressed or ascendant; membranaceous, orange or yellowish, apothecia scutellæform; disk yellow, orange or greenish-yellow. Spores ellipsoid, polar-bilocular or simple.

6. **T. chrysophthalmus**, (L.) Norm. Thallus tufted, more or less erect, spreading; the branches narrow, linear, smooth or puberulent; tips mostly fibrillose and ramulose; apothecia few; disk orange, which is often fibrillose. Spores ellipsoid. Parmelia chrysophthalma. Ach. M. L. 267.

In Hanover Township, Cook County, and Will County; at Lemont, on old rails in woods. Also on old oak trees near the lake shore, Lake View.

7. **T. parietinus**, (L.) Norm. Thallus, foliaceous, sub-orbicular, crenate, yellow and orange, lobes appressed, sub-imbricate, radiant, rounded; apothecia small to ample, orange, border entire or flexuous. Spores ellipsoid. Parmelia, Fr., L. E. 72; Xanthoria, Th. Fr. L. Scand., 145.

Along the lake shore, on oaks and poplars; also in Lemont and elsewhere.

8. **T. lychneus**, (Nyl.) Thallus reduced, substellate, or effuse, yellow; apothecia scattered; yellow-orange, entire or granulate. Spores ellipsoid.

On walnut and hickories, west part of Cook County and elsewhere. It has a numerous synonomy, and is often considered a variety of No. 7.

9. **T. concolar**, (Dickson) Tuckerm. Thallus foliaceous, orbicular, greenish-yellow; divisions narrow, much dissected; beneath pale, fibrillose; apothecia small, yellow or rufous. Spores numerous. Physcia candelaria, Nyl., etc.

On various trees along the lake shore at Glencoe. All the genus may be distinguished by the golden or yellow thallus. May be mistaken for Placodium.

Parmelia, (Ach.) De Not. Thallus imbricate--foliaceous, lobate or laciniate, appressed, membranaceous; more or less fibrillose, sometimes densely so; apothecia scutellæform, slightly pedicellate. Spores ellipsoid. *Vide* Schwendener.

10. **P. perlata,** (L.) Ach. Thallus greenish-glaucescent, or whitish; dilated; lobes rounded, often sorediate, undulate; black beneath, with brown margins; apothecia small to large, rufous, entire. Ach. L. U. 459, etc.

Found throughout our territory on oaks and other trees, and on boulders near Lemont.

11. **P. perforata,** (Jacq.) Ach. Thallus whitish, much dilated; coriaceous, membranaceous, glaucescent, smooth, sinuate lobed; beneath black or fuscous; fibrillose; apothecia very large, perforate, cyathiform; disk fuscuous or rufous. Spores ellipsoid. Ach. L. U. 459, etc.

On various trees in Cook and Will Counties. A common species.

12. **P. crinita,** Ach. Thallus dilated, membranaceous, surface covered with minute granules and branchlets; black beneath and fibrillose; lobes ciliate; apothecia ample, cyathiform; disk chestnut. Fr., L. E., 58.

On oaks in Hanover Township; on detached rock near Lemont; not common.

13. **P. cetrata,** Ach. Thallus greenish, dilated, rather thin, smooth; beneath black and hispid; the sinuate lobes sorediferous on the margins, narrowed, soon prolonged; apothecia medium size, chestnut. Ach. Syn. L., 198, etc.

On trees and stones near Lemont and westward.

14. **P. tiliacea,** (Hoffm) Fl. Thallus smooth, closely adnate, much narrowed, membranaceous, margins crenate; lobes rounded, sinuate-laciniate; apothecia medium size, few, margins crenulate. Fr. L. E. 59, etc.

On oaks at Riverside, Lemont and Hanover. There are varieties in the South.

15. **P. tiliacea,** Fl., var. **sulphurosa,** Tuck. Medullary layer sulphur-yellow; otherwise like the species. Tuckerm, Syn. 1, 57.

Found near Elgin on oak trees. Will probably be found elsewhere.

16. **P. borreri**, Turner. Thallus cinereous, glaucescent; lobes large or narrow, rugulose; beset with round soredia; membranaceous; pale brown beneath, fibrillose, dense; apothecia large, badio-rufous, margin entire. Spores rounded. Turner. Linn. Tr. 148. Ach. L. U. 461, etc.

Very common everywhere in our territory, especially on oaks.

17. **P. borreri**, Turn., var. **rudecta**, Tuckerm. Thallus isidioid. Ach. Syn. 197. Tuckerm. Syn. 58.

Occurs on oaks in the west part of Cook County, and at Lemont and Joliet.

18. **P. saxatilis**, (L.) Fr. Thallus glaucous-cinerascent, membranaceous, more or less lacunose, ramose; isidiophorous; beneath black and densely fibrillose; lobes sinuate-multifid, incised; apothecia large, disk fuscous, or spadiceous, margin subcrenulate. Spores ellipsoid. Fr. L. E. 61. Nyl. Syn. 388.

Found on trees in Cook County near Elgin and on recent sandstones and boulders at Lemont.

19. **P. saxatilis**, Fr., var. **sulcata**, Nyl. On bluff boulders and stones near Lemont, and in Will County. Very fine specimens may be gathered in LaSalle County.

The very numerous soredia, which are round or oblong, confluent and reticulate, mark the variety. Tuck. Syn. 58.

20. **P. physodes**, (L.) Ach. Thallus loosely attached, substellate, whitish, coriaceous, glaucous; beneath fuscous-black, no fibrils; lobes many cleft, complicate, often with white soredia; apothecia medium to large, badio-rufescent, margin nearly entire. Spores subellipsoid. Ach. S. L. 218. Tuckerm. Syn. 59, etc. Occurs on oaks in Cook and Du Page Counties, and elsewhere,

There are several varieties in other States.

21. **P. caperata**, (L.) Ach. Thallus substramineous, dilated, coriaceous, undulate-plicate, often sorediate; beneath black, fibrillose; lobes sinuately-laciniate, rounded tips; apothecia large, chestnut, margin subcrenulate, often sorediate. Ach. S. L. 196, etc.

Very common on oaks everywhere. The fruit is seldom seen here, but the lichen is conspicuous for size and color.

22. **P. conspersa**, (Ehrh.) Ach. Thallus straw-colored, greenish, laciniate, much divided, appressed, often isidiophorous in the centre; beneath fuscous-black, sparingly nigro-fibrillose; lobes sinuate, often crenate, or pinnatifid, complicate; apothecia large, chestnut, margin subcrenulate. Spores ellipsoid, simple. Ach. L. U. 486. Muhl. Catal. 1818 Tuckerm. Syn. 64, etc.

In Lemont and Will County on stones; also found near Elgin on old wood. This species has a wide distribution in the United States.

23. **P. colopodes**, (Ach.) Nyl. Thallus coriaceous, glaucescent, beneath dark brown, spongy nap, with a few fibrils; lobes sinuate-cleft, flat; apothecia large, disk chestnut. Spores numerous. Tuck. Syn. 61; Nyl. Syn., etc.

On oaks near Lemont. There is a very narrow lobed form not as yet observed here.

Physcia, (D. C., Fr.) Th. Fr. Thallus foliaceous, variously divided, stellate, somewhat fibrillose; apothecia scutellæform. Spores ellipsoid, bilocular.

24 **P. speciosa**, (Wulf.) Nyl. Thallus greenish, glaucous, loosely stellate, appressed, beneath corticate, rhizinæ whitish; lobes sinuate, flat, pinnatifid, with powdery margins; apothecia medium size, sessile, margin crenulate; disk fuscous. Spores bilocular Parmelia speciosa, Ach. L. U. 480; Fr. L. E. 80; Tuck. exs. n. 81; Calkins exs.

Occurs at Riverside on oaks; on hickories, near Elgin and other localities.

25. **P. stellaris**, (L.) Nyl. Thallus albo-glaucescent, stellate, appressed, orbicular; beneath pale, fibrillose, lobes linear, many-cleft, compaginate, or discrete; apothecia small, sessile; disk fuscous-black, often grey-pruinose, margin entire or crenulate. Parmelia, Fr. L. E. 82.

This, the most common species of the genus, occurs everywhere on oaks, hickories and other trees, as well as on rocks.

26. **P. stellaris**, (L.) Nyl., var. **aipolia**, Nyl. Thallus brown becoming blackish, beneath black, fibrils hispid; apothecia subcrenate, Nyl. Scand., 111. Parmelia, Ach. S. L. 215.

Found on boulders of the prairies and on stones at Lemont.

27. **P. tribacia,** (Ach.) Tuckerm. Thallus smallish, membranaceous, sub-stellate, glaucescent; beneath white, fibrillose; lobes short, appressed; margins erose, granulate; apothecia small, sessile, black or pruinose, margin sub-entire. Lecanora, Ach. S. L. 191. Tuck., etc.

On elms at Glencoe, and in other localities on hickory. A variety of P. stellaris, (d.) of Tuck. Syn., 75.

28. **P. obscura,** (Ehrh.) Nyl. Thallus stellate, orbicular, appressed, epruinose, glaucous, fuscescent, beneath black, fibrillose, lobes many-cleft, flatish; ciliate; apothecia rather small; disk nigro-fuscous, margin entire. Spores bilocular. Th. Fr., Scand. 142. Harmelia, Fr. L. E. 84.

On hickories and other trees in west part of Cook County; near Lemont and Joliet on trees and calcareous rocks. Quite variable everywhere, having several forms.

29. **P. adglutinata,** (L.) Nyl. Thallus often slightly olivaceous, also cinerascent and brown, adheres closely to substrate, small; lobes thin, flat, compaginate; apothecia small, disk nigro-fuscous, margin entire. Nyl. Syn. 438, etc.

On elms and hickories in Cook and Will Counties. This is a well marked species.

30. **P. granulifera,** (Ach.) Tuckerm. Thallus glaucescent and white, pruinose, be-sprinkled with powdery granules; beneath pale, corticate, fibrils black; lobes multifid, dentate-crenate; apothecia small, inflexed margin crenate. Parmelia, Ach. Syn. L. 212. Tuckerm. Obs. 390.

Found on hickories near Elgin and at Lemont. A variety of P. speciosa (e. of Tuck.), but quite marked.

FAMILY 3. PELTIGEREI.

Peltigera, (Willd., Hoffm.) Fee. Thallus membranaceous, lobate, frondose, foliaceous; beneath somewhat villous, marked with veins, occasionally cyphels; apothecia peltæform. Spores fusiform. Cortical layer, in some species consisting of gonidia, in others, of gonimia.

31. **P. rufescens**, (Neck.) Hoffm. Thallus large, coriaceous, rotund, lobate, lobes elevated and crisp, ash colored to reddish-brown; beneath reticulated with brown veins, fibrillose; apothecia on lobules, large; disk revolute, rufo fuscous. Spores acicular. Fr. L. E. 46. Tuck. exs. n. 104. .Calkins. exs.

Occurs at Glencoe in ravines and on hillsides, on earth and old mossy logs. Found also at River Forest near the Desplaines River and throughout our territory.* Tuckerman says this species stands in embarrassing relations to P. canina.

FAMILY 4. PANNARIEI.

Heppia, Naeg, Thallus squamose-foliaceous, monophyllous, Gonimous layer of gonimia; apothecia round, immersed. Spores ovoid.

32. **H. despreauxii**, (Mont.) Tuckerm. Thallus small, round, smooth, or regulose, green; apothecia separate, or in rosettes, sunken in thallus, disk reddish or salmon-colored.

Found on calcareous earth near Lemont. This curious lichen being very small is not easily seen. It seems always to be associated with Endocarpon hepaticum in habitat, and has often been mistaken for a fungus.

Pannaria, Delis, Thallus squamulose, subfoliaceous or monophyllous, the hypothallus spongy or obsolete; apothecia scutellæform, with both thalline and proper margins, frequently biatorine. Gonimous layer of both gonidia and gonimia.

33. **P. nigra**, (Huds.) Nyl. Thallus squamulose, minute, lead colored, and mostly merged into a granuloid crust; apothecia small, biatorine, sessile; disk black, margin entire.

On calcarieous rocks near Lemont and in Will County.

FAMILY 5. COLLEMEI.

Collema, (Hoffm.) Fr. Thallus greenish, cortical layer obsolete; gonimia in chains; apothecia very small to middle size; scutellæform. Spores variously shaped.

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* Other species of this genius are likely to occur.

34. **C. pycnocarpum**, Nyl. Thallus small, pale, green, sub-orbicular, lobes radiate, narrowed, fenestrate, ribbed, the marginal lobules densely fruited; apothecia small; disk reddish, excluding margin. Spores ovoid ellipsoid, bilocular, decolorate. Nyl. Syn., 115.

Found on elms and shrubs in Will County; rare.

35. **C. microphyllum**, Ach. Thallus small, fuscous-green, or olivaceous, orbicular, diffract or effuse, microphylline; lobes often granulate, crenate at centre; apothecia abundant, small, urceolate, rufescent, flat; thalline margin entire, concolorous. Spores sub-muriform. Ach. Syn. L., 310.

On elm bark; Cook and Will Counties; rare.

36. **C. flaccidum**, Ach. Thallus dark-green, or olive-green; lobes large, expanded, bullate, entire, with concolorous granules, undulate plicate, paler beneath; apothecia small, sessile; disk rufescent, margin entire. Spores ovoid. Ach. Syn. L., 322; Tuck. Gen., 91.

Occurs near Elgin and Joliet on oaks and elms; rare. May be found on rocks also.

37. **C. tenax**, (Sw.) Ach. Thallus thin, lobes wide, appressed, also ascendant, lead-colored; apothecia often immersed; disk rufescent, the margin entire or rogose. Var. c. of **C. pulposum**, Tuck., exs. n., 148. Calkins, exs.

Found near Joliet on calcareous soil; rare.

38. **C. limosum**, Ach. Thallus thin, dark green, scattered, slightly crenate, pulpy when wet; apothecia rufous, immersed but becoming superficial, margin prominent, entire or somewhat crenulate. Spores in fours in the thekes. Nyl. Syn., 110.

Inhabits clay soil. Will County; rare.

39. **C. granosum**, (Wulf.) Schaerer. Thallus small, rigid, gelatinous when wet; lead-colored; lobes ample, rounded or elonggated and divided; apothecia of medium size, sessile; disk reddish, dark. C. dermatinum, Ach. L. U., 64.

On mossy rocks near Desplains River, Will County.

Leptogium, (Fr.) Nyl. Thallus foliaceous, or fruticulose, cortical layer distinct; gonimia in chains; apothecia sub-scutellæform, lecanorine or sub-biatorine. Spores of various forms.

40. **L. lacerum,** (Sw.) Nyl. Thallus plumbeo-fuscescent, lacero-laciniate, ample, wrinkled, the lobes dilated above and sinuate, thin, crisped and dentate; apothecia small, pale-red, sub-sessile, margin entire. Spores ovoid-ellipsoid. Ach. L. U. 657.

On elms in Hanover Township, near Elgin; also in Will County.

41. **L. chloromelum,** (Sw.) Nyl, Thallus small to large; orbiculate, rigid; plumbeo-virescent, lobate, plicate, rugose; apothecia medium size, lecanorine, plane, rufous, the thalline margin granulate. Spores ovoid. Nyl. Syn. 128. Tuck. Gen. 98.

On elms in Hanover Township, near Elgin; also in Will County. The varieties are found further south.

42. **L. myochroum,** (Ehrh. Schaerer) Tuckerm. Thallus ample, coriaceous, membranaceous, sub-monophyllous, also loosely attached, lead colored and blackish; beneath has a whitish nap; apothecia reddish, border plicate. Spores ellipsoid. Tuck. 99.

On the same substrate as the preceding species, Will County.

43. **L. pulchellum,** (Ach.) Nyl. Thallus small to large, rosulate, glaucous-green, lobes plicate, papulose, wrinkled above and beneath and pitted; apothecia medium size, lecanorine, sub-pedicellate, disk fusco-rufous, finally excluding the smooth or finally rugose thalline margin. Spores ovoid-ellipsoid, sub-muriform, decolorate. Collema, Ach. Syn. L. 321. Tuck. Syn. 161. Calkins, exs.

Found on calcareous rocks in Will County, and on elms in Cook County. Better developed further south in this State.

FAMILY 6. LECANOREI.

Placodium, (D C.) Naeg. & Hepp. Thallus crustaceous, lobed, suffruticulose, or uniform; apothecia sub-scutellæform, lecanorine or sub-biatorine; disk usually yellow or orange.
Spores ellipsoid, polar-bilocular, colorless.

44 **P. cinnabarinum,** (Ach.) Anzi. Thallus rimose-areolate, more often of applanate scales, crenate, and crowded into an imbricate crust, orange; apothecia minute or small, adnate; disk orange, margin entire. Spores ellipsoid. Lecanora, Ach, L. U. 402. Parmelia, Fr. L. E. 165.

Very common on calcareous and arenaceous rocks in our territory.

45. **P. microphyllum,** Tuckerm. Thallus squamulose; from greenish-yellow to orange; scales adnate, crowded and concealed by granules; apothecia small, adnate, flat, orange; proper margin entire, the thalline one crenulate. Spores ellipsoid. Tuck. Syn. 174.

Found near Lemont, on old fence panels, and in Will County.

36. **P. aurantiacum,** (Light.) Naeg. & Hepp. Thallus uneven and chinky, warted, broken; yellow or variously colored, often bordered by a dark hypothallus; apothecia fair size, sessile, zeorine, flat; disk lemon, saffron or tawny colored; proper margin thin, the thalline one crenulate or may be obsolete. Parmelia, Fr. L. E. 165. Lecanora, Nyl. Scand. 142. Tuck. Syn. 174. Calkins, exs.

On elms and poplars at Glencoe; on hickories and other trees along the Desplaines river; on rocks at Lemont, and elsewhere. Thallus and apothecia lemon color, in our specimens; abundant.

47. **P. ferrugineum,** (Hudson) Hepp. Thallus chinky, verruculose, ash-colored, upon a black hypothallus; apothecia fair size, mostly biatorine, sessile, flattish; disk opaque, rust-colored, or fulvous, bordered by a crisp proper margin, often enclosed in a thalline one. Parmelia, Fr L. E. 170. Caloplaca, Th. Fr. Scand. 182. Tuck. Syn. 177.

On oaks along the Desplaines river and near Elgin on hickories. Not so common as the preceding species, but plentiful.

48. **P. vitellinum,** Ehrh. Thallus effuse, tartareous, squamaceous, of crenate granules, crowded into heap-like areoles, often dispersed, greenish-yellow; apothecia small, sessile, flat, yellow; thalline margin granulate-crenate. Spores numerous, simple and bilocular. Fr. L. E. 162. Nyl. Scand. 141. Tuck. Syn. 180.

Found on dead wood and rails in Lemont Township. Not common for lack of proper conditions.

Lecanora, (Ach.) Tuckerm. Thallus crustaceous; mostly uniform; apothecia scutellæform, or zeorine. Spores ellipsoid, or oblong.

49. L. **pallida**, (Schreb.) Schaerer. Thallus thin, membranaceous, smooth, cream-colored or darker; apothecia sessile, tumid; whitish-buff, white-pruinose, the entire margin disappearing. Spores ellipsoid. Parmelia, Schaer. Spicil. 396. Tuck. Syn., 185.

On oaks and hickories near Joliet. This species and its varieties are more abundant in some localities than in ours. Varies greatly as to the apothecia.

50. L. **subfusca**, (L.) Ach. Thallus whitish or cinerascent, smooth, rimulose, granulate, verrucose, soon diffract; apothecia plano-convex, disk fuscous, becoming black, often pruinose, the thalline margin entire, flexuous or crenate. Spores ellipsoid. Parmelia, Schaer. Spicil. 389, etc.

Very common in our territory on oaks and other trees and also on arenaceous rocks. There are several varieties. I have specimens from Europe, Japan and the West Indies. Many species, so called, have been made from this cosmopolite.

51. L. **subfusca**, (L.) Ach., var. **allophana**, Ach. Thallus granulate, verrucose; apothecia fuscous-black, margin flexuous and crenate. Lich. Uni. Nyl. 395.

On oaks in various localities; not uncommon.

52. L. **subfusca**, (L.) Ach., var. **argentata**, Ach. Apothecia smaller, margin entire. Spores smaller. Lich. Univ. Nyl. Syn. 393.

Occasionally found on shrubs and trees in our territory.

53. L. **subfusca**, (L.) Ach., var. **distans**, Ach.

Common on the same substrates as the preceding forms; apothecia flat and pale, margin crenulate. Spores smaller than in number 52. L. distans, Ach. L. U. 397.

54. L. **hageni**, Ach. Thallus cinerascent, verruculose or wanting; apothecia small or minute, crowded, plane or tumid; pale to fusco-rufous or sometimes pruinose; margin white, commonly crenate or entire; may be excluded. Th. Fr. Scand. 250. L. umbrina, (Massalongo) Nyl.

On rails near Lemont and on calcareous rocks. Some conditions are known as L. umbrina, (Mass.) Nyl. The observer cannot but see close relations in L. hageni to L. subfusca and the next following species.

55. L. **hageni**, Ach., var. **sambuci**, (Pers.) Nyl., L. Sambuci, Nyl. Th. Fr.

Found rarely on elms, poplars and shrubs in Will County.

56. L. **varia**, (Ehrh.) Nyl. Thallus verruculose, greenish or yellowish; apothecia small, the disk yellow to flesh-color or rufescent, thin; margin entire or crenulate, often excluded. Spores oblong-ellipsoid. Nyl. Scand. 163.

On oaks near Elgin, Lemont and elsewhere. There are numerous varieties.

57 L. **varia**, (Ehrh.) Nyl., var. **symmicta**, Ach. Thallus thin, whitish; apothecia yellowish, disk swollen, excluding margin; biatoroid. Fr. L. E. Nyl. Tuck. Syn.

On various trees.

58. L. **calcarea**, Sommerf. Thallus white, contiguous; apothecia innate, emerging; disk grey-pruinose. Spores ovoid-ellipsoid. Nyl. Scand. 154.

On calcareous rocks at Joliet.

59. L. **calcarea**, Sommerf., var. **contorta**, Fr. Areoles discrete, pale lead-color. L. calcarea, f. Hoffmani, Nyl.

On calcareous rocks at Joliet. A very curious form.

60. L. **cervina**, (Pers.) Nyl. Thallus tartareous, areolate, squamulose; scales sub-peltate, from yellowish to chestnut; apothecia medium size, impressed, becoming superficial; disk reddish-brown, thalline margin obsolete. Nyl. Scand. 174. Tuck. 202.

On detached sandstones in Cook and Will Counties.

61. L. **privigna**, (Ach.) Nyl. Thallus wanting; apothecia varying from small to large; sessile, appressed; scattered or aggregated; disk dark red; margin elevated, rugged, contorted. Spores numerous, minute Lecidea, Ach. M. L. 49. Sarcogyne, Koerber, Syst. 266. Biatorella, Th. Fr. Scand. 407.

Found on calcareous pebbles near Elgin, on rocks near Joliet.

62. **L. privigna,** (Ach.) Nyl., var. **pruinosa,** (Auctt.) Apothecia small, appressed, sunken; disk gray-pruinose. Sarcogyne, Koerber. Lecanora, Nyl.

On sandstone boulders near Lemont. This, and the two preceding forms, are so nearly related that one is puzzled to distinguish them without a familiar acquaintance with suites of specimens from different localities. The most perfect representations of the variety are from the Trenton rocks of LaSalle County, Illinois, and from Tennessee.

The variety clavus, Koerber, should be found in our limits also.

63. **L. perproxima,*** Nyl. Spec. nova. Resembles L. erysibe, Ach., nevertheless the spores are larger, .014-18 by .007 mm., and the hymenial gelatine with iodine is a beautiful blue, becoming deep blue. In appearance it resembles L. cæsio-cinerea, Nyl.

On calcareous rocks at Joliet and elsewhere.

64. **L. erysibe,** Ach. Thallus cinerous, thin, diffract; apothecia fusco-rufous, plane or convex.

On calcareous rocks in Will County; abundant.

Rinodina, Mass. Stizenb. Tuckerm. Thallus crustaceous, apothecia scutellæform, often zeorine, then lecideine. Spores ellipsoid, bilocular, brown.

65. **R. sophodes,** (Ach.) Nyl. Thallus gray or cinereo-fuscescent; apothecia small, appressed; disk flat, fuscous-black; margin entire. Nyl. Scand. 148. Th. Fr. Scand. 199. Tuck. Syn. 207.

On boulders near Lemont. I have not met with it elsewhere so far north.

66. **R. bischoffi,** (Hepp.) Koerber. Thallus ash-colored or fuscescent; thin, farinose; apothecia small, sessile, flat or convex; margin fuscescent or cinerascent. Spores broad, fruit finally lecideoid. Th. Fr. Scand. 204. Tuck. Syn. 209.

On calcareous rocks at Joliet and Lemont. A little known species. Occurs more abundantly further south and west.

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*L. perproxima, Nyl. Spec. Nova. Proxima L. erysibe, Ach. Sporis nonnihil majoribus, long. 0.014-18, crass. 0.007 millim., et gelatina hymenialis. Iodo bene cœrulescente, cœrulescentia persistente. Facies fere Lecanora cæsio-cinerea, Nyl.

Pertusaria, D C. Thallus crustaceous, continuous, smooth or verrucose; apothecia globular, difform, closed; enclosed in thalline verrucæ, opening by pores (ostioles); explanate, lecanoroid. Spores generally large, ellipsoid.

67. **P, velata,** (Turn.) Nyl. Thallus white, glaucescent, rugose, chinky, rimose, radiate near the circumference; apothecia small, adnate, pale yellowish, white powdery; the thalline margin disappearing in the fruit. Muhl. Br. L. 274. Tuck. Syn. 212.

On rocks and trees.

68. **P, multipuncta,** (Turner.) Nyl. Thallus ash colored, rugose, verrucose, zonate at the circumference; apothecia small, in verrucæ—2-4; lecanoroid, finally elevated; disk becoming black, soon excluding the thalline margin and often forming powdery heaps. P. faginea, Tuck. Syn. N. E. 64.

On oaks and hickories; not rare.

69. P. **communis,** D C. Thallus glaucescent, smooth, chinky or rugose-verrucose, may become zonate at the circumference; apothecia small, adnate, depressed, sub-globose, difform, closed, the numerous ostioles sunken and black. Spores generally in twos, sometimes solitary. Porina pertusa, (L.) Ach. Syn. L. 109, etc.

Common on oaks everywhere in our territory.

70. **P, leioplaca,** (Ach.) Schaer. Thallus whitish or more commonly pale-yellowish; apothecia medium size, globular and difform, often crowded together; depressed ostioles indistinct, often blackening. Nyl. Scand. 181. Tuck. Syn. 215.

On oaks near Elgin and elsewhere.

71. **P, pustulata,** (Ach.) Nyl. Thallus greenish or whitish; chinky, or verruculose; apothecia very small, hemispherical and difform, globular or confluent; ostioles black. Spores in twos. Porina, Ach. L. U. 309. Tuck. Syn. 215.

On trees; general in distribution here and elsewhere.

Conotrema, Tuckerm. Thallus crustaceous, uniform; apothecia urceolate, truncate-conoid. Spores cylindraceous, plurilocular.

72. C. **urceolatum,** (Ach.) Tuckerm. Thallus smooth, becoming chinky and rugged, whitish; apothecia small, urceolate, from black to pruinose; prominent, elevated. Lecidea, Ach. L. U. 671. Gyrostomum, Fr. Tuck. Gen. L. 129. Conotrema, Tuck. Syn. 217.

This, the only species of the genus and has a wide distribution. Found on maples and poplars in Cook and Will Counties; also further west and south in Illinois. The genus Gyalecta should occur with this in our territory, affording at least the two species, G. lutea and G. trivialis, Willey. They are very small and may have escaped discovery here, though found in southern Illinois.

Urceolaria, (Ach.) Flotow. Thallus crustaceous, uniform; apothecia urceolate. Spores ovoid-ellipsoid, muriform, pluri-locular; fuscescent.

73. U. **scruposa,** (L.) Nyl. Thallus tartareous, rugose-plicate; glaucous, ash-colored or white; apothecia immersed, but emerging, urceolate, large, black; disk somewhat cinereous; margin denticulate, hidden by the thalline one, if present. Nyl. Scand. 176. Tuck. Syn. 222. Muhl. Cat. 1818.

Found on calcareous earth in Will County and on dead cedars along the banks of the Illinois; rare.

TRIBE II. LECIDEACEI.

FAMILY 7. CLADONIEI.

Cladonia, Hoffman. Thallus squamulose, rarely granulose or deficient; apothecia variously colored, but never black; soon inflated and cephaloid; podetia fistulous, funnel or tubulose in shape, often shrub-like. Spores small. Tulasne, Mem. sur. les Lich. Tuck. Gen. Lich. and Syn.

74. C. **mitrula,** Tuckerm. Thallus of small squamules, minute, green; podetia short, granulate, glaucescent; apothecia confluent, flesh-colored or brown. Tuck. in Fl. Cestrica. 444. Nyl. Syn. 203.

On earth and old logs in Cook and Will Counties. Generally distributed west and south.

75. **C. pyxidata,** (L.) Fr. Thallus squamulose; podetia cup-shaped, warty, turbinate, ash-colored; the cups cyathiform; often proliferous; apothecia brown. Nyl. Syn. 192. Tuck. Syn. 241.

Formerly abundant on earth along the lake shore in woods. Common elsewhere in our territory, on earth and rocks.

76. **C. pyxidata,** (L) Fr., var. **Pocillum,** Ach. Has foliaceous thallus and reduced podetia.

Occurs rarely in our limits.

77. **C. fimbriata,** (L.) Fr. Thallus squamulose, but reduced; the podetia elongated, often white-powdery; cups with erect margins; apothecia brown. Fr. L. E. 222.

Found on rotten logs at Glencoe, and elsewhere on logs and earth.

78. **C. fimbriata,** (L.) Fr , var. **tubaeformis,** Fr. Podetia slender, elongated, tawny-brown, often with squamules; cups smaller, toothed or entire; proliferous, fimbriate; apothecia confluent. Tuck. Syn. 241.

Found throughout our territory. Synonomy numerous.

79. **C. gracilis,** (L.) Nyl. Thallus squamulose, but often wanting, ash-green; podetia slender to robust, corticate, polished, proliferous; apothecia fuscous. Nyl. Syn 196, C. ecmocyna, Ach.

On earth in Will County.

80. **C. gracilis,** (L.) Nyl., var. **verticillata,** Fr. Cups proliferous from the centre, dilated.

On earth in Will county.

81. **C. squamosa,** Hoffman. Thallus much divided; podetia much branched; apothecia cymose, fuscous. Fr. L. E. 231. Nyl. Tuck. Syn. 246.

On earth and rotten logs in Will County and the western part of Cook.

82. **C. delicata,** (Ehrh.) Fr. Thallus reduced, more often of crowded white granules; podetia short, slender; apothecia heaped, fuscous. Nyl. Syn. 210. Tuck. Syn. 6. C. parasitica, Schaer.

Found near Elgin on old stumps, near Lemont, and elsewhere. Very closely related to C. squamosa, Hoffm. *Vide.* Fr. L. E.

83. **C. furcata,** (Hudson) Fr. Thallus squamulose but small; podetia fruticulose, elongated, corticate; brownish-green, fertile summits corymbose, pervious; apothecia brown. Fr. L. E. 229. Tuck. Syn. 247.

On calcareous soil near Joliet and elsewhere.

84. **C. rangiferina,** (L.) Hoffm., var. **sylvatica,** L. Horizontal thallus wanting; the podetia two to four inches high; cinerascent, erect, branched and imbricate, terminal ones divaricated, corymbose. A more delicate form than the species. Fr. Tuck., etc.

Occurs on dead wood and sandstones in the Desplaines Valley, but is more common further west. The species is found from the arctic circle to the tropics in one form or another. Known as the "Reindeer moss."

85. **C. cristatella,** Tuck. Thallus squamulose, minute, cut and crenate; podetia fair size, often elongated, cylindrical, corticate; smooth or wrinkled, summits fastigiate; apothecia scarlet, or as var. b. Tuck. ochrocarpia, C. flœrkiana Tuck Syn. N. E. 55, etc.

Found occasionally in our territory on old decaying logs and stumps.

86. **C. macilenta,** (Ehrh.) Hoffm. Thallus squamulose, minute, crenate, lobate; podetia cylindrical, slender, granulose-pulverulent above; apothecia terminal, confluent, scarlet. Fr. L. E. 240. Tuck. Syn. N. E. 55.

On earth and logs in woods near Joliet; rare. This and No. 85 may be easily identified by the scarlet fruit.

Myriangium, Mont. and Berk. Thallus cellulose, orbiculate, plicate-striate at the circumference, nodulose; apothecia lecanoroid. Spores oblong-ovoid.

87. **M. duriaei,** (M. & B.) Tuckerm. Thallus crustaceous, adnate, becoming free, fuscous; apothecia elevated, blackish, disk with depressed, entire margin. Tuck. Gen. L. 140. M. curtisii, M. & B.

Collected several years ago on Corylus near River Forest; not observed elsewhere. Common south. Its position among the lichens is considered doubtful.

FAMILY 8. LECIDEEI.

Biatora, Fr. Thallus various or deficient; apothecia diverse in color, becoming soft and swollen when wet. Spores ellipsoid and simple, or assuming different forms, colorless, numerous.

88. **B. coarctata,** (Ach.) Th. Fr. Thallus cinereous, of minute squamules, rimose-areolate; apothecia small, fuscous or blackish, connivent or open, sometimes flat. Spores ovoid-ellipsoid. Lecidea, Nyl. Scand. 196. Tuck. Syn. Pt. 2. 15. Parmelia, Fr. L. E. 104.

On calcareous and arenaceous rocks in Will County; also found on detached sandstones in Cook County. A widely distributed and variable species.

89. **B. varians,** Ach. Thallus of minute granules compacted into a yellowish or greenish crust, which is granulate or broken; apothecia very small, yellowish, rufous or blackish; disk flat, margin thin. B. exigua, (Chaub.) Fr. L. E. 278.

On oaks and hickories near Elgin and Lemont.

90. **B. rubella,** (Ehrh.) Rabenh. Thallus yellowish or grayish-green, effuse, confluent; apothecia luteo-rufescent, or reddish-brown; scattered or congregate, becoming tumid and margin excluded, the latter often whitish. Spores pluri-locular. Lecidea, Schaer. Spicil. 168. Bacidia, Th. Fr. Scand. 344. Biatora, Tuck. Syn. Pt. 2. 44.

This widely diffused species occurs in our county on hickories and oaks. It is variable, and a number of varieties, fourteen or more, have been created species. Each has an extensive synonomy.

91. **B. fusco-rubella,** Hoffm. Thallus granulate, rugose, chinky, ash-colored; apothecia medium size, sessile, flat; disk often turgid, rust-colored, chestnut, or even black. Bacidia, Th. Fr. Scand. 346. Lecidea spadicea, Ach. Syn. L. 34. Tuck. Syn. Pt. 2. 43. (Var. b.)

In same localities as the preceding species.

92. **B. suffusa,** Fr. Thallus the same as in No. 91. Apothecia ample, reddish brown, suffused partially or wholly with white; disk rufescent, becoming darker, turgescent, excluding the margin, suffused with white. Tuck. Gen. Lich. 166. (Var. c.) Tuck. Syn. Pt. 2. 43.

On hickories in Hanover, Cook County, and near Lemont and Joliet.

93. **B. inundata,** Fr. Thallus scurfy, greenish, rimose-areolate; apothecia minute, sessile or adnate, flat or convex; tumid-brownish, black, often excluding the margin; hypothecium pale. Spores slender. Secoliga, Stizenb. Bacidia, Koerb. Biatora. Tuck. Syn. Pt. 2. 45.

In all our territory on detached rocks or stones along streams; the thallus is best shown on sandstones.

94. **B. cyphalea,** Tuckerm. Thallus thin granulose, cinerascent; apothecia small, dark reddish or rust-colored. Tuck. Syn. Pt. 2. 51, and Gen. L. 168.

Rare on elms near the Fox River; may be found elsewhere.

Lecidea, (Ach.) Fr. Tuckerm. Thallus various, crustaceous, squamulose or evanescent; apothecia patellæform, horny. Spores colorless. Fr. L. E. Tuck. Syn.

95. **L. enteroleuca,** Fr. Thallus granulose and cinerascent, often wanting; apothecia small to large, adnate, convex, often excluding margin, black. Spores ovoid-ellipsoid. Fr. L. E. 331. Tuck. Syn. N. E. 67. Nyl. Scand. 217.

This species has many forms and has been described under various names. Some of them occur on rocks and mosses, others on trees. It is found on maples in Will County. It is the only species of the genus within our limits so far as known. There are six described varieties in the United States.

Buellia, (De Not.) Tuckerm. Thallus mostly uniform; apothecia patellæform. Spores ellipsoid, brown or decolorate.

96. **B. parasema,** (Ach.) Th. Fr. Thallus cinerascent or darker, rugose, granulate, glaucescent; apothecia sessile, black; disk flat, often turgid; margin thin. Lecidea, Fr. Tuck. Syn. N. E. 67. L. disciformis, Nyl.

On oaks near Elgin and elsewhere on dead wood. Occurs everywhere in North America; a variable species.

97. **B. schaereri.** De Not. Thallus granulose, often wanting, cinerascent; apothecia very small, black, flat; disk turgescent and margin wanting. Lecidea nigritula, Nyl. Scand. 238.

Found on an old stump near Lemont, also on old rails; not common. Is also found in Grundy and LaSalle Counties.

TRIBE 3. GRAPHIDACEI.

FAMILY 9. OPEGRAPHEI.

Opegrapha. (Humb.) Ach. Nyl. Thallus hypophlæous, or, if exposed, thin; apothecia normally lirellæform.

98. **O. atra.** (Pers.) Nyl. Thallus thin or wanting; apothecia sessile, black, simple, flexuose; disk open, canaliculate, proper margin thick, elevated, wavy.

Throughout our territory on oaks, hickories, cherries, etc.

99. **O. varia,** (Pers.) Fr. Thallus white, pulverulent; apothecia prominent, elongate, oblong, elliptical, attenuate at the ends, brownish-black, dilated in the centre; margin inflexed.

On various trees in Cook and Will Counties.

Graphis. (Ach.) Nyl. This genus has been fully discussed by Nylander, who followed the thought of Acharius, and by Tuckerman, in his Genera Lichenum, 203; Syn Pt 2. 119. Thallus crustaceous, uniform; apothecia mostly lirellæform, and branching, but in some species rounded, difform; the proper exciple colored or black. Differentiated from Opegrapha by the spores.

100. **G. scripta,** (L.) Ach. Thallus thin, whitish, even or rugose, sub-tartareous; apothecia immersed or half immersed, slender, width uniform, simple or branched, obtuse at ends; proper margin narrow, wavy; thalloidal margin tumid. Spores colorless.

Common everywhere on oaks, hickories and other trees; apothecia variously branched. There are a number of varieties which may occur here.

101. **G. dendritica,** Ach. Thallus white or yellowish, thin, pulverulent; apothecia brownish-black, immersed, broad, flexuose-branched, forked; disk broad, often cæsio-pruinose; margin thin.

On oaks and various trees within our limits. These two species seem to be the only ones of this genus in northern Illinois. One other can be added for the southern portion of the State. When compared with the exuberance of forms in Florida, derived, however, from semi-tropical or tropical sources, this is a small number. The limitation of species is well illustrated by tracing this genus from south to north.

FAMILY 10. GLYPHIDEI.

Arthonia, (Ach.) Nyl. This genus, containing a great number of species mostly tropical, is one of the most perplexing. Dr. Nylander, more than twenty years ago, described about one hundred species. Henry Willey in his "Synopsis," published in 1890, admits three hundred and forty-eight species, and mentions a few more that he had not seen. About eighty of these are from the United States, four or five of which were discovered by the author. The genus should have been spelled Ardonia, according to its derivation from the Greek, but long usage has sanctioned the present spelling. The genera Chiodecton and Glyphis, which immediately precede

Arthonia, are not found in our territory, but inhabit Florida. We have several species of Arthonia, two so abundant as to be easily identified.

102. **A. lecideella,** Nyl. Thallus green, uneven, effuse; apothecia abundant, small, round, plain, pruinose. Spores oblong-ovoid. Nyl. En. 337. Tuck. Gen. 221. Willey, Syn. 16.

On hickories and Cratægus throughout our territory.

103. **A. spectabilis,** Fl. Thallus thin, white; apothecia black, difform, angulate, plain or convex, often bordered by the thallus. A. dispersa, Duf. A. polymorpha, of Muhl. Catal. 1818. Willey, Syn. 51.

On maples at Glencoe, Riverside and elsewhere. It is also found on other trees. Synonyms numerous.

104. **A. diffusa,** Nyl. Thallus white, effuse or wanting; apothecia round or difform, plane or convex, pruinose. A. willeyi. Tuck. in litt. Willey, Syn. 36.

On hickories and maples in Will County; not common.

105. **A. pyrrhuliza,** Nyl. Thallus white, thin; apothecia reddish, slender, much divided, ramose. Willey, Syn. 15.

On oaks in Will County; rare. Was once considered the A. medusæa of Tuckerman. May occur on Cratægus, in which case it is more likely to be noticed.

106. **A. radiata,** (Pers.) Th. Fr. Thallus whitish, darkening, or obsolete; apothecia dark-brown, stellate, difform or ramulose, erumpent. Opegrapha, Pers. (1794). Arthonia, Th. Fr. Arctic. 240. A. astroidea, Ach. Syn. 6. Willey, Syn. 44.

Has many synonyms, and until lately was known as A. astroidea, Ach. Found on oaks near Elgin and elsewhere. The variety swartziana, Nyl. should also occur within our limits.

107. **A. taediosa,** Nyl. Thallus indeterminate; apothecia erumpent, linear, heaped, few branched and sometimes round.

On maples in the Desplaines valley; also found on oaks. The name is very applicable, its habit, as to form, may be called sportive.

NOTE--Tribe 4, including the genera Siphula, Sphærophorus, Acroscyphus, Acolium, Calicium and Coniocybe, have not been found in our territory. The two latter genera are possibilities.

SERIES II. ANGIOCARPI.

TRIBE V. VERRUCARIACEI.

FAMILY 11. ENDOCARPEI.

Endocarpon, (Hedw.) Fr. Thallus foliaceous, or crustaceous, peltate; apothecia imbedded, minute. Spores colorless. For exposition consult Tuck. Gen. Lich. 246.

108. E. **miniatum,** (L.) Schaer. Thallus cinereous, large, peltate, lobate-crenate, umbilically affixed; underside smooth or rugose, fulvous; apothecia numerous and minute, immersed, brownish.

On calcareous rocks near Lemont and elsewhere. The species has a wide distribution; is found in Europe and Japan, being used in the latter country, as I am informed by Prof. Minakata, as an article of diet. The thallus is often one inch or more in diameter. Abundant in Illinois.

109. E. **miniatum,** (L.) Schaer., var. **complicatum,** Schaer. A polyphyllous form.

Found on limestone rocks at Lemont and elsewhere.

110. E. **miniatum,** (L.) Schaer., var. **muhlenbergii,** Ach.
Occurs with the first named and is scarcely distinct.

111. E. **hepaticum,** Ach. Thallus fuscous, squamose, small, round or angular; apothecia numerous, blackish. Ach. L. U. 298. (1810). Nyl., etc.

On calcareous earth at Lemont and in Will County.

112. E. **pusillum,** Tuckerm. Thallus very small, greenish, thin; apothecia minute, imbedded.

Very abundant throughout our territory on various rocks and stones. The genus Endocarpon was founded upon this species. V. pallida, Nyl. Ach. L. U.

113. E. **rufescens**, Ach. Thallus rufescent, squamose, lobes rotundate, incised, complicate. Ach. L. U. 304. (1810).

On earth in Will County. Not easily distinguished from E. hepaticum, but is darker and thinner, and the spores are smaller.

FAMILY 12. VERRUCARIEI.

SUB-FAMILY PYRENULEI.

In the following genera we approach the limits marking the close relations of the lower lichens with the fungi. The absence or slight indications of a thallus have caused Lichenologists to doubt whether certain species of Verrucaria and Pyrenula, should be classed under these names, or as Sphærias. The effort has been made to eliminate the myco lichens, all corticolous, from the true ones. Fries expressed this idea,* and that a distinction be made between the saxicoline and corticoline groups, which, seeming a natural arrangement, I have followed. Tuckerman conceived the sub family as naturally divided into two great classes: "the one," to quote his own language, "(confined to inorganic substrates) of true lichens, with a well marked thallus, and the other (confined to organic substrates) of plants, the thallus of which is more or less obsolete, and the affinity close to Pyrenomycetous Fungi." But even with a fair array of evidence in support of this arrangement, Nylander dissents from this view.†

Sagedia, (Mass.) K'br. Tuckerman. Thallus crustaceous; apothecia innate-superficial. Koerber. Syst. 362. Nyl. Pyrenoc. 36, classed under Verrucaria. Tuck. Gen. Lich. 263.

114. S. **oxyspora**, Tuckerm. Thallus thin, effuse; apothecia black, ellipsoid, conoid; perithecium black. V. albissima, Nyl. Scand.

Occurs on Betula papyracea along the lake shore near Glencoe. The few native birch will soon disappear and with them this species.

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*Syst. Orbis Viget. 264.

†Nyl. Pyrenoc. .

Verrucaria, (Pers.) Tuckerm. Thallus crustaceous, sub-tartareous, mostly uniform; apothecia globular, black, immersed or prominent; perithecium black. The synonomy of this genus is numerous. Tuck. Gen. Lich. 263. Verrucaria is restricted here to the rock and earth lichens, species taken from Pyrenula and other genera, which, as Tuckerman remarks, shows a full and harmonious spore-character. In Europe a large number of forms have been included under Verrucaria, but Fries and Nylander have made a great reduction.

115. **V. prospersella,*** Nyl. Spec. nova. Thallus uninterruptedly white or scattered, becoming chinky with age reaction; apothecia pyrenoid, wholly black, small (breadth, .15 mm.), somewhat globose, rather prominent. Spores 8. colorless, oviform, 1 septate, .018-22 by .008-.011 mm. The paraphyses few or scarcely any. Hymenia gelatinous-reaction. Occurs on siliceous rocks near Chicago. (Calkins). This species seems to approach V. inconspicuam, Lahm, from which it differs by its larger spores. Likewise near to V. saxicola, Mass. The calcicolous species, V. ruderella, Nyl. also occurs in the same locality. Nyl Chall. p. 217.

First found at Riverside. Described and published by Dr Nylander in his "Obs." Lichens Japoniæ, Paris, 1890 Abundant so far as known.

116. **V. pyrenophora,** (Ach.) Nyl. Thallus tartareous, chinky, ash-colored or continuous and rugulose; apothecia prominent, black, large conoidal, sessile; perithecium dimidiate. Spores 8, colorless. Ach. L. U. 285. (1810).

On rocks at Riverside, Lemont and throught our territory.

117. **V. nigrescens,** Pers. Thallus nearly black, crustaceous, uneven, crumbling, and often raised around the apothecia; apothecia black; perithecium dimidiate. Spores 8, colorless.

On limestone along streams in various localities.

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*V. prospersella, Nyl, Spec. nova. Thallus albidus continus, vel passim obsolete rimulosus; apothecia pyrenio integre nigro, minuta (latit. 0, 15 millim.), subglobulose prominula: sporae 8 nae incolores oviformes 1-septatæ, long. 0.018-22, crass. 0,008-011 millim: paraphyses graciles parcæ vel vix ullæ. Gel. hym. I. Super saxum siliceum haud procul a Chicago (Calkins). Accedere videtur ad V. inconspicuam, Lahm. a qua mox differt sporis majoribus. C. fr. etiam V. saxicola, Mass.--Calcicola ibidem (idem) V. ruderella, Nyl. Chall. p. 217.

118. **V. fuscella,** Fr. Thallus crustaceous, dark brown, areolate-diffract. black-limitate, smooth: apothecia minute, immersed in the areolæ. Spores 8, colorless. Ach. L. U. 289.

Found on detached calcareous rocks near Joliet; not common as far as observed. A well defined and interesting species.

119. **V. muralis,** Ach. Thallus whitish, tartareous, mealy or wanting; apothecia black, semi-immersed, hemispherical; perithecium dimidiate.

Found on limestone near Joliet and in Cook County, and sometimes on old mortar.

120. **V. viridula,** Ach. Thallus greenish olive, areolate-diffract, areolæ polygonal, smooth or rugose, effuse; apothecia black, numerous, semi immersed. Spores 8, colorless.

On detached calcareous rocks, north bluff at Lemont

Pyrenula, (Ach., N. & H.) Tuckerm. Thallus hypophlœoid, subcortical, rarely ektophlœoid, superficial; apothecia denudate, perithecium black, ellipsoid-oblong, etc.

121. **P. gemmata,** (Ach) Naeg. Thallus whitish, thin; apothecia black, medium to large, prominent, convex; perithecium black, dimidiate. Spores colorless. Ach. Meth. Lich. 120. (1803). Acrocordia, K'br.

On oaks and hickories at River Forest and in all our territory This species is closely related to Sphæria mastoidea, Fr.

122. **P. punctiformis,** (Ach.) Naeg. Thallus thin, effuse, brown; apothecia black, shining, minute, sessile-innate, conoid; perithecium dimidate. V. epidermidis, Nyl. Offers a near approach to Fungi according to Fries, Wallroth, Tuckerman.

On Quercus alba near Elgin and elsewhere.

123. **P. thelaena,** (Ach.) Tuckerm. Verrucaria, Ach.
On birch trees at Glencoe; on maples and hickories near Riverside.

124. **P. nitida**, Ach. Thallus pale yellowish or olive, waxy, smooth; apothecia black, in size medium to large, though sometimes small, invested by the thallus, globose; perithecium black. Spores fuscous. Sphæria, Weigel, Obs. 45. (1772). Verrucaria, Ach. L. U 279. Nyl., etc.

On oaks and maples throughout our territory, perhaps not abundant, yet it may be in some places. The very pale thallus will identify its location more easily. American specimens vary greatly in size.

125. **P. glabrata**, Ach. Thallus whitish, thin; apothecia variable in size, black, hemispherical, conoid; perithecium black. Spores fuscous. Ach. Syn. 791. Nyl. Pyren. 47.

On oaks near Elgin and Joliet; apparently not common. Some Florida specimens are of extraordinary size, making their proper position questionable.

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THE
Chicago Academy of Sciences

THE

Pleistocene Features and Deposits

OF THE

Chicago Area.

BY

FRANK LEVERETT.
U. S. Geological Survey.

BULLETIN No. II

OF THE

Geological and Natural History Survey

ISSUED MAY, 1897.

CHICAGO:
David Oliphant, Printer, 178 Monroe Street.

LETTER OF TRANSMITTAL.

CHICAGO, ILLINOIS, April 1st, 1897.

DEAR SIR:

By direction of the Board of Managers of the Geological and Natural History Survey of The Chicago Academy of Sciences, I herewith submit to you for publication as Bulletin No. II of the Survey, the report on The Pleistocene Features and Deposits of the Chicago Area, prepared by Frank Leverett, of the United States Geological Survey, to be issued under the rules of the Academy governing such matters.

Respectfully,

WILLIAM K. HIGLEY,
Chairman.

THOMAS C. CHAMBERLIN,
Pres't of The Academy of Sciences.

DEDICATION.

This Bulletin is dedicated to Mr. George H. Laflin, who, interested in the advancement of science and in the work of our institutions of learning, has by his generosity made its publication possible.

The Board of Managers of the Geological and Natural History Survey of The Chicago Academy of Sciences:

WILLIAM K. HIGLEY, Chairman,
CHARLES S. RADDIN, Secretary.
THOMAS C. CHAMBERLIN.
GAYTON A. DOUGLASS.
THOMAS T. JOHNSTON.

THE GEOLOGICAL SURVEY.

The Board of Management of the Geological and Natural History Survey take pleasure in presenting the second of its proposed publications, a list of which may be found on the fourth cover page.

The history and aims of the survey are outlined in the first bulletin, The Lichen Flora, prepared by Mr. W. W. Calkins, and published through the generosity of Mr. Albert Dickinson. It is only necessary, therefore, to repeat here the extent of the territory covered by the survey. This area comprises Cook and Du Page Counties, and the nine north townships of Will County, in Illinois, and a portion of Lake County, Indiana, giving a surface of about forty-eight or fifty miles square, or a land surface of nearly 1800 square miles.

The present bulletin on the Pleistocene Features and Deposits of the Chicago Area, has been prepared by Mr. Frank Leverett, of the U. S. Geological Survey. The Board desires to express its appreciation of the time and labor that must have been taken from the stress of other duties in the preparation of this very creditable work as well as of the assistance given to Mr. Leverett by individuals and institutions, recognition of which has been made in the body of the text.

The Board wishes further to make acknowledgement of the courtesy extended by the Sanitary District of Chicago, which, through the kindness of Mr. T. T. Johnston, Assistant Engineer, prepared the maps and profiles from Mr. Leverett's manuscript copy.

All into whose hands this bulletin may come, will join with the members of the Board in appreciation of the generosity of Mr. George Laflin, whose prompt response to the request for funds to publish the bulletin is but another instance of the liberality which has marked his attitude towards the Chicago Academy of Sciences.

THE BOARD.

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Pleistocene Features and Deposits of the Chicago Area.

By FRANK LEVERETT.

INTRODUCTORY STATEMENT.

The Chicago area here discussed embraces not only the site of the city, but adjacent territory west and south, nearly to the Fox and Kankakee Rivers, and north nearly to the line of Illinois and Wisconsin. It is made to include the first great moraine which sweeps around the head of Lake Michigan, as well as several weak morainic lines lying nearer the lake. It includes also the ancient beaches of Northeastern Illinois and a portion of the outlet of the body of water which formed them. It is a country exceptionally full of varied and interesting features.

Some of the features, especially those pertaining to the old lake and its outlet, are discussed by Dr. Edmund Andrews, in an early volume of the Transactions of the Chicago Academy (1). The same features and some of the leading features of the glacial deposits were briefly discussed by Dr. H. M. Bannister, in his official reports to the State Geologist (2). A description of the principal moraine traversing this district, based upon studies by Prof. T. C. Chamberlin and Prof. L. C. Wooster, is given by Professor Chamberlin in an early report of the United States Geological Survey (3)

The paper which follows aims to discuss these features in the light of a somewhat detailed study of Pleistocene deposits, which I have had the privilege of making in this and adjacent districts. Carried on as this study has been, under the direction of Prof. T.

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(1) The North American Lakes considered as Chronometers of Post glacial Time. By Dr. Edmund Andrews, Transactions of The Chicago Academy of Sciences. Vol. II, 1870, pp. 1-23.

(2) Geology of Cook County. By H. M. Bannister. Vol. III, 1868, pp. 239-244.

Geology of DeKalb, Kane and DuPage Counties. By H. M. Bannister. Vol. IV, 1870, pp. 111-113.

Geology of McHenry and Lake Counties. By Dr. H. M. Bannister. Ibid, pp. 126-131.

(3) Preliminary Paper on the Terminal Moraine of the Second Glacial Epoch. By Thos. C. Chamberlin, Third Annual Report, U. S. Geol. Survey, 1881-82, pp. 322-325.

C. Chamberlin, I have had the benefit of counsel and guidance, which has been of great service and which it is a pleasure to acknowledge.

The studies in Illinois, upon which the present paper is based, were entered upon in 1886, near the beginning of my study of Pleistocene deposits, and the greater part of the work in the Chicago Area was done in that and the following season. The study in Northern Illinois was carried into greater detail than in most of the territory subsequently covered, chiefly because of the complexity of the features. Nearly every township was traversed at intervals so close as to give opportunity to see practically all of the surface, to examine the best natural exposures, as well as railway cuttings and other artificial exposures, and to collect records of nearly all the important borings. Portions of the district here discussed have been recently re-examined. This has in a measure made good the loss consequent upon the lapse of time, and has brought the interpretation into harmony with the present state of knowledge of Pleistocene events or stages.

OUTLINE OF TIME RELATIONS OR GLACIAL SUCCESSION.

The complexity of the glacial events is such that it will be advantageous to outline as clearly as possible at the outset the recognized glacial succession and thus learn the position of the drift of the Chicago Area in the series of drift sheets displayed in the Mississippi Basin and adjacent territory. The outline given below aims to present simply the recognized subdivisions. These may prove to differ widely in rank or importance. The main divisions here outlined seem to be much longer than the secondary divisions and they may be of very unequal length. They appear to have the rank of an epoch, or main division of a period, except the divisions of Lake history, which, perhaps, should be substages. The outline aims to cover the events between the deposition of the oldest recognized drift sheet and the final recession of the ice sheet into the region north of the Great Lakes. That region may furnish several additional substages and possibly one or more stages. The outline differs from that published by Prof. T. C. Chamberlin, in a recent number of the Journal of Geology (1), only in being a fuller presentation of substages in the Wisconsin drift series, and in including the lake history of this region.

OUTLINE OF THE DRIFT SHEETS AND INTERVALS.

1. Oldest recognized drift sheet—the Albertan of Dawson.
2. First, or Aftonian, interval of recession or deglaciation.
3. Kansan drift sheet of the Iowa geologists.
4. Second interval of recession or deglaciation.
5. Illinoian drift sheet.
6. Third, or preloessial, interval of recession or deglaciation.
7. Iowan drift sheet and main loess deposit.
8. Fourth, or postloessial, interval of recession or deglaciation.
9. Early Wisconsin drift sheets.
    Substage 1. Shelbyville morainic system.
    Substage 2. Champaign morainic system.
    Substage 3. Bloomington morainic system.
    Substage 4. Marseilles morainic system.
10. Fifth interval of recession, shown by shifting of ice lobes.

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(1) Journal of Geology, Chicago University. Vol. IV, No. 7 October-November, 896, pp. 872-876.

11. Late Wisconsin drift sheets.
    - Substage 1. Great bowlder belts and accompanying moraines.
    - Substage 2. Valparaiso morainic system.
    - Substage 3. Lake-border morainic system.
12. Lake Chicago submergence.
13. Emergence of plain, covered by Lake Chicago.
14. Partial resubmergence of plain, covered by Lake Chicago.
15. The present stage of Lake Michigan.

It appears from the above outline that the late Wisconsin series covers the entire Chicago Area. A brief discussion of the several drift sheets which preceded the Late Wisconsin will be of advantage, however, both for comparison and for the interpretation of the deposits of earlier drift found beneath the late Wisconsin within the Chicago Area.

Explanation of Map of North America.—The position of the four main centers of glaciation is indicated, viz.: The Cordilleran, confined chiefly to the region west of the Rocky Mountains; the Keewatin, extending over the area between the Rocky Mountains and Hudson Bay and reaching Central Missouri at its farthest point south; the Labrador, extending over the peninsula of Labrador, and the Great Lakes, with its extreme southwest terminus in Southern Illinois, and the eastern borders of Missouri and Iowa. (The eastern New England, New Brunswick, Nova Scotia and Newfoundland glaciation may be from small independent centers, but this can scarcely be considered as demonstrated.) The fourth center of glaciation is the Greenland, which is still largely ice covered. The Driftless Area of Southwestern Wisconsin and border districts stands between the fields covered by the Keewatin and Labrador ice sheets. South from this driftless area is a narrow belt covered first by the Keewatin and later by the Labrador ice sheet, as indicated in the text.

The principal glacial lakes are perhaps sufficiently outlined to be deciphered. Lake Agassiz is shown clearly. Lake Iroquois occupies the Ontario basin and border districts. The Warren and Algonquin Lakes are more difficult to decipher. Lake Warren is now restricted by several geologists to a body of water that discharged across Southern Michigan from the Erie-Huron basin. At that time Lake Chicago was occupying the south end of the Lake Michigan basin. A small predecessor of Lake Warren, called Lake Maumee, had southwestward outlet to the Wabash. A lake discharging southwestward from the Lake Superior basin was probably a contemporary of Lake Warren. At the Lake Warren stage the ice sheet was apparently covering the region about the straits of Mackinac, much of Georgian Bay, and the eastern end of Lake Ontario. Lake Iroquois, in the Ontario basin, is of later date than Lake Warren, and is thought to have been held in on the northeast by the ice sheet, as shown by studies of

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It appears from the above outline that the late Wisconsin series covers the entire Chicago Area. A brief discussion of the several drift sheets which preceded the Late Wisconsin will be of advantage, however, both for comparison and for the interpretation of the deposits of earlier drift found beneath the late Wisconsin within the Chicago Area.

Explanation of Map of North America.—The position of the four main centers of glaciation is indicated, viz.: The Cordilleran, confined chiefly to the region west of the Rocky Mountains; the Keewatin, extending over the area between the Rocky Mountains and Hudson Bay and reaching Central Missouri at its farthest point south; the Labrador, extending over the peninsula of Labrador, and the Great Lakes, with its extreme southwest terminus in Southern Illinois, and the eastern borders of Missouri and Iowa. (The eastern New England, New Brunswick, Nova Scotia and Newfoundland glaciation may be from small independent centers, but this can scarcely be considered as demonstrated.) The fourth center of glaciation is the Greenland, which is still largely ice covered. The Driftless Area of Southwestern Wisconsin and border districts stands between the fields covered by the Keewatin and Labrador ice sheets. South from this driftless area is a narrow belt covered first by the Keewatin and later by the Labrador ice sheet, as indicated in the text.

The principal glacial lakes are perhaps sufficiently outlined to be deciphered. Lake Agassiz is shown clearly. Lake Iroquois occupies the Ontario basin and border districts. The Warren and Algonquin Lakes are more difficult to decipher. Lake Warren is now restricted by several geologists to a body of water that discharged across Southern Michigan from the Erie-Huron basin. At that time Lake Chicago was occupying the south end of the Lake Michigan basin. A small predecessor of Lake Warren, called Lake Maumee, had southwestward outlet to the Wabash. A lake discharging southwestward from the Lake Superior basin was probably a contemporary of Lake Warren. At the Lake Warren stage the ice sheet was apparently covering the region about the straits of Mackinac, much of Georgian Bay, and the eastern end of Lake Ontario. Lake Iroquois, in the Ontario basin, is of later date than Lake Warren, and is thought to have been held in on the northeast by the ice sheet, as shown by studies of

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Gilbert not yet published in full. Lake Algonquin represents a stage where an eastward outlet, from Georgian Bay by Trent River, to Lake Iroquois, was open, the outlet to the St. Clair being for a time above lake level. At that time the emergence of the south end of the Lake Michigan basin, discussed in the text, may have occurred. For the use of this map plate we are indedted to the Inland Educator Company of Terre Haute, Indiana.

ALBERTAN, OR OLDEST RECOGNIZED DRIFT SHEET.

Dr. George M. Dawson has recently called attention to a very aged drift sheet found by him in the province of Alberta, east of the Rocky Mountains, in Southern Canada (1). Its relation to drift sheets in the United States is not definitely worked out. It is overlain by a sheet that is probably either the sub-Aftonian (formerly Kansan) of Professor Chamberlin, or the somewhat later sheet to which the Iowa geologists have applied the name Kansan. Should the lower sheet prove to be the one that overlies the Albertan drift it will be necessary to place that drift in a still earlier stage than the sub-Aftonian of Professor Chamberlin, for it is described to be of markedly greater age than the drift sheet which overlies it.

AFTONIAN INTERVAL OF RECESSION.

The interval of recession or deglaciation, following the deposition of the lower till sheet of Southern Iowa, and named by Professor Chamberlin the Aftonian, from the type locality near Afton, Iowa, is characterized by soil and weathering of such a marked character that it no doubt will be recognized widely as the detailed study progresses. In the present stage of investigation it scarcely can be separated from soils of other horizons, except in the district which lies outside the Illinoian and the Iowan drift sheets. This district has not as yet received much study, hence the extent to which the soil remains intact is not known.

In Southeastern Iowa and Western Illinois several instances of the occurrence of a black soil between beds of till, and thought to be the Aftonian, have come to my notice. There is an element of uncertainty from the fact that it is near the border of the drift sheet, where minor oscillations of the ice margin are liable to have occurred, which may have caused the burial of soils whose extent is limited. It is not yet made certain that they mark a prolonged interval, such as Professor Chamberlin finds to be exhibited in the type locality near Afton.

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(1) Bulletin Geological Society of America. Vol. 7, pp. 31-66. Issued Nov. 1895

KANSAN DRIFT SHEET OF THE IOWA GEOLOGISTS.

This is a sheet which has much importance in the drift series, for it constitutes a large part of the drift of Southern Iowa and Missouri and probably remains in extensive sheets beneath the later drift in districts to the north. It apparently extends into Western Illinois a short distance, beneath the Illinoian drift sheet. It is a sheet that has as yet received but little attention, the chief study given it being in Southeastern and Southern Iowa.

SECOND INTERVAL OF RECESSION OR DEGLACIATION.

This interval is known not by a recession and readvance of the same ice sheet, nor a sheet with the same gathering ground, but by the recession of one ice sheet and the advance of another ice sheet into the region thus abandoned. It has been studied only in Southeastern Iowa, where the Illinois lobe has encroached upon the territory which had been occupied by a more western lobe.

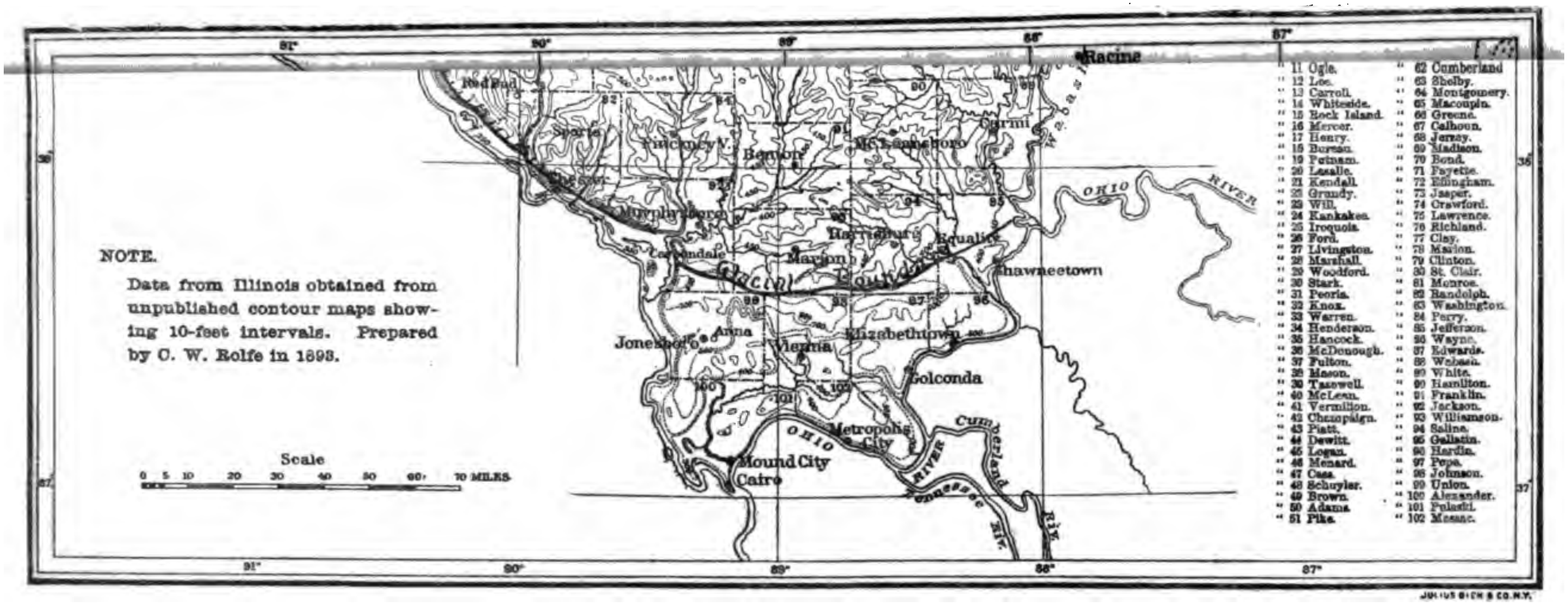
Evidences of the lapse of a long period between the withdrawal of one ice sheet and the invasion of the other are clear and decisive. The drift of the earlier sheet is a very calcareous till, yet its surface had been leached to a depth of several feet before the Illinois lobe encroached upon it.

Accompanying the leaching was the formation of a black or humus stained soil, numerous exposures of which are to be seen in Southeastern Iowa under the drift of the Illinois lobe.

There was also much erosion of the surface by stream action. Prior to the discovery of the extension of the Illinois lobe into Southeastern Iowa it had been noted by Professor Chamberlin, as well as by the writer, that Southern Iowa presents a more eroded appearance than Illinois and the southeastern counties of Iowa. In the former district remnants of the original drift plain are confined to narrow strips between water courses, while in the latter district such remnants are far more extensive, comprising much more than half the surface. It is planned to make a careful measurement of the relative amounts of erosion in the two districts, for erosion studies made with proper analytical method promise to furnish the most satisfactory means available for measuring such time intervals.

ILLINOIAN DRIFT SHEET.

Under this name is included the sheet of drift which covers Western Illinois and extends a few miles into Southeastern Iowa.



NOTE.

Data from Illinois obtained from unpublished contour maps showing 10-feet intervals. Prepared by C. W. Rolfe in 1893.

Plate 2.

MAP OF THE ILLINOIS LOBE

Modified from Plate CVIII and CIX. Seventeenth Annual Report, U. S. Geological Survey, Part 2, 1896.

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It remains to be determined whether it should be made to include all the drift of Southern Illinois and the oldest sheet of drift in districts to the east from Illinois. Further study is also necessary to determine whether the drift on the border of the Driftless Area in Northwestern Illinois and Southern Wisconsin is so recent as the Illinoian sheet. There may be found in the region referred to a sheet or sheets of drift corresponding in age with one or both of the sheets in Iowa that are earlier than the Illinoian drift sheet. The drift of these regions is thus only provisionally referred to the Illinoian stage.

The Illinoian sheet has in Southeastern Iowa and Western Illinois a variable thickness, ranging from ten feet or less up to fully 100 feet, with an average of perhaps forty feet. It is scarcely so thick as the older sheet of Iowa and Northern Missouri, whose edge it overlaps in Southeastern Iowa. In Southern Illinois, also, the drift is not so thick as in the old sheets of Iowa and Missouri, being even thinner than in Western Illinois. The same is true of the old drift sheets of Southern Indiana and Southern Ohio. In all these districts the older drift is not so thick as the newer. The Illinoian drift sheet has mainly a plane surface, but near its margin there is a tendency to morainic ridging. The ridging is a subdued form, the ridges being one-half to one mile or more in width, with a relief of but twenty-five to fifty feet. The extent of the Illinoian sheet and the distribution of its ridges are shown on the accompanying map (plate 2).

Explanation of Map of Illinois.—In this map the extent of the Illinoian drift sheet is represented. Its extension into Missouri, near St. Louis, is conjectural, but the extension into Iowa is well established. The several moraines formed in the early and late Wisconsin stages are indicated by shading with dots. The extent of Lake Chicago in Northeastern Illinois and Northwestern Indiana is also represented. These features have been added to the map as published by U. S. Geological Survey. The 50 foot contours appear except in the hilly parts of Illinois and in western Indiana where only 100 foot contours are shown.

THIRD OR PRELOESSIAL INTERVAL OF RECESSION OR DEGLACIATION.

There is between the Illinoian drift sheet and the overlying mantle of loess and associated silts a well-defined soil horizon. There is also leaching of the till to depths seldom less than four feet and often much more. It is, therefore, an interval of considerable importance. Its length, however, appears to be somewhat less than that of either of the two earlier intervals.

Prof. Worthen early recognized this soil horizon at the base of the loess and made numerous references to it in the Geology of Illinois. Being situated near the surface, it is much more frequently exposed to view than the soils at lower horizons. Probably, also, it has been subjected to less disturbance and removal than soils which were overridden by the ice sheet.

IOWAN DRIFT SHEET AND MAIN LOESS DEPOSIT.

This sheet of drift was brought to notice by Mr. W J McGee in his early papers on the drift of Northeastern Iowa, where it is commonly referred to as the "upper till." It was found by Mr. McGee to be of the same age as a deposit of loess which covers Southeastern Iowa, but which was excluded from much of Northeastern Iowa by the ice sheet (1).

This drift sheet Mr. McGee found to be markedly different in its stony ingredients from the sheet that underlies it. It is separated from that sheet by a prolonged interval. This interval, it now appears, comprises not only the third or preloessial interval of Western Illinois, but the time covered by the Illinoian stage of glaciation and the deglaciation interval which preceded it. Comprising thus the time of two stages of deglaciation and one of glaciation, the interval shown in Northeastern Iowa is necessarily very marked.

The Iowan sheet is thought to be represented in Northern Illinois by a sheet of drift found mainly east of Rock River, though extending in places west of that stream. This sheet is concealed within a few miles east of Rock River by a later drift sheet (the early Wisconsin).

Both in Iowa and Illinois the sheet referred to the Iowan stage is perceptibly fresher than the sheet of the Illinoian stage of glaciation. The depth of leaching is, on an average, one to two feet less than on the Illinoian drift sheet. The erosion of streams is also less, apparently not more than half as great as in the Illinoian drift sheet.

FOURTH OR POST-LOESSIAL INTERVAL OF RECESSION OR DEGLACIATION.

This interval is shown to be one of considerable length by the amount of valley excavation which occurred between the deposition of the loess and the succeeding stage of glaciation. At the close of the loess deposition the main valleys, such as the Missouri, Mississippi, and Illinois, were filled throughout most of their lower courses to heights of 75 to 100 feet, or more, above the present streams. But before deposits from the waters, contributed by the succeeding glaciation, were poured into these valleys, they had been cut down about to the present level of the streams and in some cases, perhaps, to an even lower level.

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(1) See Eleventh annual report U. S. Geological Survey for a full discussion of this drift sheet.

The cutting down of the valleys indicates a marked change in altitude or at least in attitude of the land surface, and this change cannot have been accomplished in a very brief period.

EARLY WISCONSIN DRIFT SHEETS.

Under this term are included several important morainic systems, which are well displayed in the State of Illinois. The names applied to these morainic systems are in every case taken from Illinois localities. Shelbyville is derived from the county seat of Shelby County, which is situated on the outer belt of moraines. Champaign is from the city of that name in Eastern Illinois, which is situated on one of the principal members of the morainic system to which the name is applied. Bloomington is situated upon the principal member of a still later system of moraines, well displayed in Central Illinois. Marseilles is situated at a point where the moraine to which this name is applied crosses the Illinois River.

It is thought that the several morainic systems just mentioned were formed in comparatively rapid succession in the order named. At least no decisive evidence of a prolonged interval separating the formation of successive morainic systems has been discovered. It is probable that some oscillation of the ice front occurred, so that the moraines do not mark simply halts in the recession of the ice. They may mark the limits of successive advances following retreats of minor importance.

Shelbyville Morainic System.—The Shelbyville morainic system marks the southern limits of a sheet of thick drift, the thickest, perhaps, formed in Illinois at any stage of the glacial period. The distribution of the moraine may be seen by reference to the accompanying map (Plate 2). Whether the outer ridge throughout the entire extent from the Wabash River, near Terre Haute, Ind., around to the Wisconsin line, near Harvard, Ill., was occupied at any one time by the ice sheet, or whether there were oscillations by which some parts were formed earlier than others, is not yet definitely settled. Possibly the outer ridge in the vicinity of the Illinois River should be classed with the Iowan rather than the Early Wisconsin drift. This system has not much relief above the district lying on its inner or iceward border, since that district was filled with drift nearly to the level of its crest. But on the outer, or landward, border there is usually a relief of 75 to 100 feet or more. Viewed from the outer border, the moraine in places presents the appearance of a bluff or escarpment, though the rise of 75 to 100 feet usually occupies a mile or more.

By reference to the map, it will be seen that there is a feeble morainic belt lying a few miles back from the border of this drift sheet. This is included with the Shelbyville system. It seems to mark a brief halt of the ice sheet soon after it began its retreat.

The main moraine, though very bulky, has but little surface expression, much of it being nearly as smooth as the plains to the north. It consists mainly of a single ridge, but in Edgar and Coles Counties it has in places a double ridge. The feeble belt just referred to presents in places a sharper morainic expression than the main moraine, there being clusters of sharp knolls rising abuptly thirty to fifty feet, or more, above border tracts. The greater part of this belt, however, has a gently undulating surface, like that of the main moraine.

This sheet of drift, terminated by the Shelbyville moraine, is composed in the main of a soft, fresh-looking, blue till, markedly in contrast with the partially cemented brown and gray tills which underlie it, and extend southward into the outlying districts. It has long been recognized by well-drillers as a sheet very distinct from the underlying tills. From the Shelbyville moraine a sheet of soft blue till, similar to that in the moraine, is found beneath plains, as well as moraines northward over much of Northeastern Illinois. There appears to be but little difference in the structure of drift in the morainic ridges from that in plane-surfaced tracts.

Champaign Morainic System.—The Champaign morainic system, though far less bulky, is fully as complex as the Shelbyville system. It consists of several more or less distinct members separated by plains, the latter ranging in width from a mile or less up to three and even five miles. It is exposed to view only in Eastern Illinois, being combined with or overridden by the Bloomington system from the vicinity of Bloomington westward. It is poorly developed in Indiana, though small ridges are traceable across Vermillion, Parke and Fountain Counties to Montgomery County, Indiana, where they are overridden by a morainic system of the Late Wisconsin stage. The complexity of the system and the distribution of its several members may be seen by reference to the accompanying map (Plate 2).

Where best developed the members of this morainic system have a relief of fifty to seventy-five feet above plains on the outer border, but, like the Shelbyville system, the relief is less pronounced on the inner border. In Indiana the belts have less relief, seldom more than thirty or forty feet. Where best developed, the members of this morainic system are one to two miles in width. The surface is usually strongly undulating, a feature which distinguishes the moraines from the bordering nearly level plains. The surface expression is on the whole stronger than in the Shelbyville moraine.

In structure this morainic system does not differ markedly from the Shelbyville system. The ridges are composed mainly of a soft till. The soft till extends to a level somewhat lower than the base of the ridges, a feature which is thought to indicate that the Shelbyville drift is here present in considerable thickness. Beneath the soft till of the Shelbyville drift a black soil is found, which forms the surface of a drift older than the Shelbyville, presumably the Illinoian drift sheet.

Bloomington Morainic System.—This is a more prominent morainic system than the Champaign. It is traceable from Western Indiana westward across Central Illinois in a somewhat indirect course (with a re-entrant angle near Gibson City) nearly to the Illinois Valley. Whether this system crosses the Illinois just above Peoria and becomes combined with an earlier system, or has its continuation in certain local developments of morainic topography along the east side of the Illinois, northward to the bend near Hennepin, is not fully determined. It is thought that the moraine leading from the bend of the river northeastward and passing near Mendota and DeKalb belongs to this system. At the east this system is overridden by a later moraine in Benton and Warren Counties, Indiana.

The portion east from the Illinois River has, in places, three, and elsewhere two well-defined members separated from each other by narrow plains. The outer member of the system has generally a relief of 75 to 100 feet above plain tracts south of it, thus approaching in strength the Shelbyville system.

In structure the drift of this morainic system closely resembles that of the two systems outside of it, being chiefly a soft blue till. It rests upon a soft till, which is thought to be the northward extension of the Shelbyville sheet. This in turn is underlain by a hard till, probably of the Illinoian stage.

The topography is of a swell and sag type, rather more pronounced than in either of the earlier systems of the Early Wisconsin stage. The undulations not infrequently extend back for several miles on the inner border of the morainic system and fade away gradually into characteristic till plain topography.

Marseilles Morainic System.—The Marseilles morainic system consists of a bulky ridge, usually with a single crest, but in places double, which encircles the basin at the head of the Illinois River, known as the Morris basin. From the north border of the basin it extends northward along the east side of Fox River to the vicinity of Elgin, beyond which it has not been separated from the moraines of the Late Wisconsin stage. At its southeastern end, also, this moraine is concealed by a moraine of the Late Wisconsin stage.

Aside from the main belt, called the Marseilles, there is a small moraine, the Minooka, which separates from the Marseilles moraine near Oswego, Ill., and passes southward into the basin at the head of the Illinois. It has not been recognized south of that stream. This moraine probably followed closely the Marseilles moraine in its deposition, and is accordingly included in the Marseilles system.

The Marseilles moraine stands 50 to 100 feet above the plain on its outer border and even higher above the basin on its inner border. Its inner border relief is much more marked than that of any of the morainic systems yet discussed. This is due largely to the thinness of the drift deposits on the inner border, there being a much smaller amount of drift there than on the inner border of the other morainic systems.

The surface expression of this moraine is very similar to that of the Bloomington system, the topography being of a sharply undulating swell and sag type. The Minooka moraine is much smoother surfaced than the Marseilles and has a relief scarcely half as great.

The structure of the drift, both in the Marseilles and the Minooka moraine, is similar to that in the other morainic systems, being chiefly a soft blue till.

FIFTH INTERVAL SHOWN BY SHIFTING OF ICE LOBES.

The evidence for this interval is based largely on the change of front or shifting in the position of the ice lobe which invaded Northeastern Illinois and districts to the north and east. It is best shown in Western Indiana, where the moraines of the later stage cross those of the earlier one at a high angle. It is thought that this change of front could not have taken place in a brief time.

In connection with this change of front there appears a remarkable increase in the number of surface bowlders, a feature which may prove to have great significance. The causes for variations in the number of surface bowlders are so little understood as yet that we scarcely are warranted even in conjecturing the import of such bowlder belts. They may signify a great recession of the ice sheet, followed by a fresh advance across the Canadian highlands, by which a new supply of bowlders was gathered up and brought down to the extreme limit reached by that advance. Such bowlders in some cases, as recently suggested by Mr. F. B. Taylor (1) may be derived from accumulations in interglacial valleys. This suggestion, however, can scarcely apply to bowlder belts of such length as are displayed in Western Indiana and Eastern Illinois.

LATE WISCONSIN DRIFT SHEETS.

The moraines of the Late Wisconsin series contain generally a larger amount of assorted material with the till than is found in the moraines and accompanying till sheets of the Early Wisconsin series. The topography also is more closely allied to the knob and basin type than to the gently undulating broad ridged type of the Early Wisconsin series.

Some attention has been given the subject of comparative amounts of surface leaching and erosion on the Marseilles moraine and the moraines of the Late Wisconsin series, but no striking contrast has been observed. A more refined investigation, however, may bring to light essential differences.

Great Bowlder Belts and Accompanying Moraines.—The bowlder belts of Northeastern Illinois and Western Indiana have attracted attention from the earliest days of exploration, as have also their continuation in Central and Eastern Indiana and Western Ohio. In the early explorations they were observed only as detached belts, but their connections are now well established. Occurring, as the bowlders usually do, in narrow, well-defined belts, they are readily traced from section to section, even where unaccompanied by peculiar topographic features. Throughout much of their course in Ohio and Indiana these bowlder belts are simply an accompaniment of well-defined belts of morainic drift. But in Western Indiana and Northeastern Illinois the bowlder

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[1] In a paper presented at the Washington meeting of the Geological Society of America, December, 1896.

belts often cross smooth plains having only occasional developments of morainic topography.

The moraines which these bowlder belts accompany are usually a strong phase of the swell and sag type bordering on the knob and basin type. They are moraines which in their northward continuation in Eastern Wisconsin assume a pronounced knob and basin type.

In northern Kane and McHenry Counties there are bulky moraines with strong expression, which do not have definite southward continuation, unless it be in the bowlder belts. It is not certain whether they are to be correlated with the much feebler, bowlder strewn moraines of Eastern Illinois and Western Indiana, with which the bowlder belts give them a possible connection. They may prove to belong to the Early Wisconsin series. In that case they were overridden without being obscured by the very bowldery drift sheet.

Valparaiso Morainic System.—This system consists of a more or less complex belt, which sweeps around the head of Lake Michigan, passing through the western and southern part of the Chicago Area. It receives its name from the city of Valparaiso, Ind., situated on its crest. As it is fully discussed on subsequent pages, further description at this point is unnecessary.

Lake Border Morainic System.—This system embraces a series of till ridges well displayed along both the western and eastern borders of Lake Michigan. Those in Lake and Cook Counties, Illinois, are discussed in detail in this paper. Similar ridges appear in Porter and Laporte Counties, Indiana, and in the western counties of Michigan as far north as investigations have been carried (to the mouth of Kalamazoo River).

THE LAKE BEACHES.

Upon the retreat of the ice sheet from the head of Lake Michigan a body of water collected in the southern end of the basin and discharged southwestward by the "Chicago outlet" to the Desplaines River. This period of discharge appears to have been followed by a period in which the water level was too low to discharge in that direction. There then succeeded another period of discharge through the southwestward outlet. This period of discharge was followed by the present lake stage with northward outlet. As this complicated lake history is discussed in some detail farther on, it is left here with this passing word.

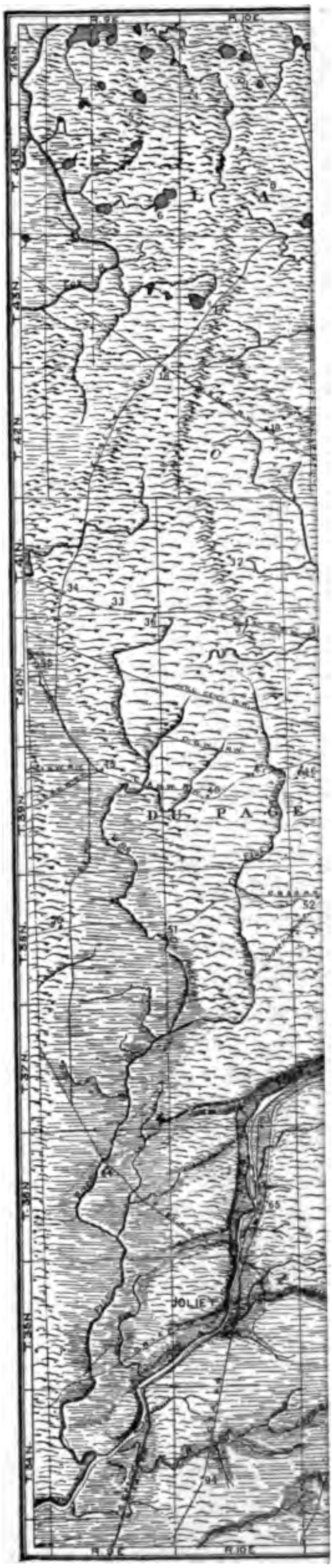
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Plate 3.

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GENERAL PHYSIOGRAPHIC FEATURES OF THE CHICAGO AREA.

The principal physiographic features of the Chicago Area were produced by the ice sheet, the rock surface being generally covered to a great depth by the drift. The variations in altitude which the region presents are produced by inequalities of drift accumulations rather than by the underlying rock, the elevation of the rock surface being but little, if any, higher in the highest parts of the area than it is in the lowest.

The most conspicuous physiographic features are the lake plain, the lake outlet, and the Valparaiso moraine. Less conspicuous features are found in the Lake Border Morainic System of northern Cook and eastern Lake Counties. These are each discussed in some detail farther on, but a brief outline of their features may be of service at this point.

The lake plain has its most extensive development in Chicago and its immediate borders as far north as Winnetka. It extends back some twelve to fifteen miles from the lake, with a general southward and westward rise, the elevation averaging about ten feet at the border of Lake Michigan and about fifty feet at the upper beach. This plain is continued into Indiana, but is greatly concealed by dunes. North from Waukegan there is a narrow plain bordering the lake, whose elevation is but twelve to thirty feet above the present lake level.

Lake plain

The portion of the shore of Lake Michigan between Winnetka and Waukegan is occupied by one of the ridges of the Lake Border morainic system, and the erosion of this ridge by the lake gives the high banks which are present in that section. Between this ridge and the Desplaines River there are a series of till ridges separated by narrow plains. The ridges rise to a height of 100 to

L. B. [illegible]

Explanation of Glacial Map of Chicago and Vicinity.—On this map an attempt is made to give a bird's-eye view of the area by means of broken profiles. The moraines appear with undulating contour, the plains with straight lines, the beaches with abrupt, step-like descent of the plain. Striae are indicated by arrows and represent bearings accurately. Some confusion of dunes with moraines may arise if it is not borne in mind that the belt of ridges bordering Lake Michigan in Lake County, Indiana, consists of sand dunes. The dunes are found for eight to twelve miles south from the lake in that county. The bars in Cook County, Illinois, also are to be distinguished from the moraines. They are much lower and narrower ridges, as shown in the discussion.

125 feet above the lake and the plains from 60 to 90 feet or more. The general elevation is, therefore, higher than in the lake plain bordering the city of Chicago.

The district between the Des Plaines and Fox Rivers in Lake, northwestern Cook and Du Page Counties, is largely occupied by the Valparaiso moraine. This moraine is interrupted by the Chicago outlet in southwestern Cook and northern Will Counties. East from this outlet it is developed along the watershed between the Kankakee River and Lake Michigan in southern Cook and eastern Will Counties and continues thence eastward, swinging gradually to the north around the head of Lake Michigan.

The highest points on the Valparaiso moraine are found in southern Lake and northwestern Cook Counties. One of these, just east of the village of Volo, stands 913 feet, and one in the northwest section of Cook County stands 910 feet above tide, as determined by the Barometric survey under Professor Rolfe. Much of the crest of the moraine in the southwestern part of Lake County rises above 850 feet. In northwestern Lake County and in northwestern Cook County it rises generally above 800 feet and a few points exceed 850 feet. In Du Page County the crest is generally about 750 feet. In Will County a few points rise above 800 feet, but the general elevation is not much above 750 feet. and this elevation is maintained eastward about to Valparaiso, Ind., where the moraine rises above 800 feet and continues with an elevation of 800 to 900 feet from that point to the borders of the St. Joseph River in Michigan.

From the Valparaiso moraine there is less descent toward the Fox River Valley than toward Lake Michigan, the elevation of the immediate border of the valley being 750 to 775 feet in Lake County and 700 to 750 feet on the borders of Cook and Kane Counties. But upon approaching the Des Plaines River the district outside the moraine becomes about as low as that along the lake, and the immediate valleys of the Des Plaines and Kankakee, in Will County, are lower than the lake surface. Farther east the district outside the moraine reaches an elevation higher than the lake level, the altitude of the Kankakee marsh at the

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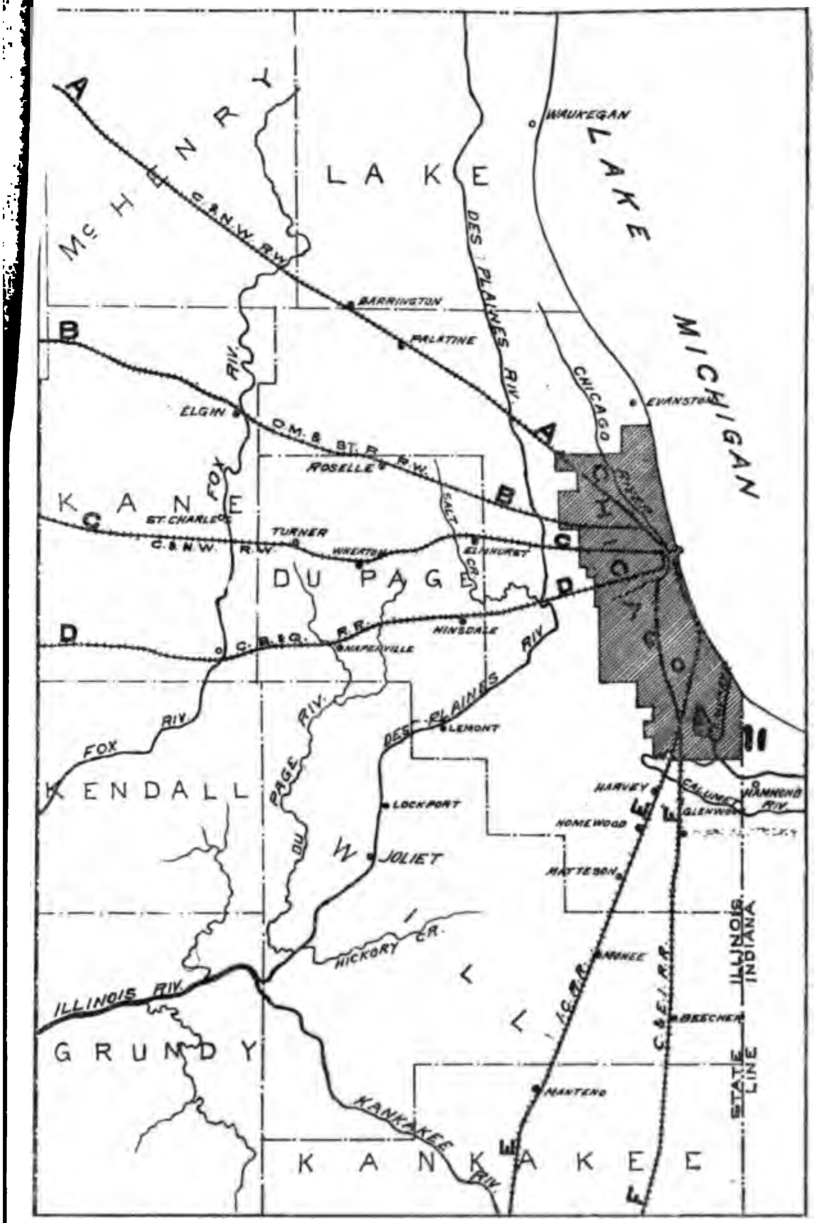
Explanation of Profile Sections.- The profile sections given in Plate 4 are based upon the railway surveys along six lines radiating out from Chicago. The distance to rock is shown by a series of well borings along each line. In cases where rock is not struck the depth of well is indicated. The vertical scale being about thirty times the horizontal, the reliefs of the region are sufficiently well outlined to be readily seen.



INDEX MAP
SHOWING
LINES OF PROFILES

Vertical Scale 30 times the horizontal.

State line being about forty to fifty feet, and its eastern end, near South Bend, fully 100 feet higher than the lake.

The lake outlet trenches the Valparaiso moraine to a level about as low as the surface of Lake Michigan, with a valley nearly a mile in average width. This is the only drainage line crossing the Valparaiso moraine in Illinois and no drainage line crosses the moraine in Indiana, though it is crossed by the St. Joseph River just north of the Indiana line between Niles and Berrien Springs in Michigan.

Some of the features just discussed are well represented on the reduced topographic map accompanying this paper. But the large map sheets of the United States Geological Survey should be consulted for the full representation of characteristic features of the plain, the outlet, and the Valparaiso moraine. It is to be hoped that the map sheets of the entire State, which Professor Rolfe has prepared, may soon be published, since they bring out clearly the main physiographic features.

THE VALPARAISO MORAINE IN ILLINOIS.

THE MORAINE.

Distribution.— At the Illinois and Wisconsin line and for some thirty miles southward the Valparaiso moraine is so closely associated in its outer or west border with earlier moraines that that border is not clearly outlined. Just south of Elgin the moraine first becomes distinct, its course there becoming east of south, while the earlier moraines bear west of south. It covers the lake region of western Lake and eastern McHenry Counties, its eastern border in Lake County being nearly coincident with that of the system of small lakes, and slightly east of the water parting between the Fox and Des Plaines Rivers.

In Cook and Du Page Counties the moraine has a breadth of not less than ten miles and in places reaches fifteen miles, its inner border being somewhat irregular. In northern DuPage County it lies entirely within the limits of the county, but farther south it encroaches on western Cook County, the inner border at the Des Plaines River being about four miles east of the county line. The outer border from Wayne to Turner Junction lies just east of the Chicago and Northwestern railroad. South from Turner Junction the West Du Page River follows the border. In southern Du Page County there is a separation into rudely parallel ridges between which are lowlands, which are utilized by the southward flowing streams, East Du Page River and Salt Creek. Near the south part of Du Page County the East Du Page is forced to turn westward into the West Du Page, for the ridges which are separate in Du Page County coalesce in northern Will County. Salt Creek has, in its lower course, left its old valley and cut a new one eastward through Proviso Township, Cook County, to the Des Plaines. The old valley passes southward through the western part of Lyons Township, almost in line with the upper portion of Salt Creek Valley, crossing the Chicago, Burlington and Quincy Railway west of Western Springs, and joining the Des Plaines about seven miles below the present mouth of the creek.

Through Will and southern Cook Counties the moraine has a southeasterly course. Its inner border is nearly parallel with the shore of Lake Michigan and distant from it about twelve miles. The Des Plaines River enters this moraine near Mt. Forest and the other lake outlet, known as "the Sag," enters it about five miles east of Sag Bridge. Between Mt. Forest and the Sag outlet the moraine covers an island situated between the outlets of Lake Chicago. The main part of the moraine crosses the Des Plaines between Lemont and Joliet and thence, continuing south of east, its crest passes near Frankfort and Monee and enters Indiana from southeastern Will County. There is a somewhat distinct outer belt following the divide between the Des Plaines and Du Page southward past Joliet and crossing the Des Plaines three to five miles below that city. This belt, east from the Des Plaines, is in places distinct from the main belt, but scarcely merits a separate name, since it is so generally united with that belt. Where distinct it is about two miles in width. Throughout much of the interval between the Des Plaines and the Indiana line this outer belt is nearly parallel with the Kankakee River and distant from it about ten miles. Near the Indiana line its border approaches the Kankakee and in Indiana follows closely the north side of the marsh drained by the Kankakee.

Relief.—The crest of the Valparaiso moraine is much higher than its outer and inner borders, but the moraine has such broad slopes that it has not a bold relief on either face. The following table of elevations is taken from the profiles of several of the railways which cross the moraine.

TABLE OF ELEVATIONS ON VALPARAISO MORAINE.

Railroad.	Inner Border.	Crest.	Outer Border.	
E. J. & E., in Lake County	720 feet.	880 feet.	770 feet.	
Wisconsin Central	683 "	823 "	778 "	
C., M. & St. P.	646 "	812 "	768 "	
C. & N. W. (Wis. div.)	650 "	867 "	772 "	
C. & N. W. (Omaha div.)	641 "	760 "	750 "	
C., B. & Q.	646 "	763 "	700 "	
Wabash	665 "	712 "	680 "	(1)
C., R. I. & P.	630 "	725 "	680 "	(1)
Ill. Central	650 "	806 "	710 "	
C. & E. I.	632 "	777 "	713 "	

(1) Outer border of main ridge.

All of the above lines cross the highest part of the moraine in their respective latitudes, except the Wabash, Chicago, Rock

Island and Pacific, and the Omaha division of the Chicago and Northwestern. These lines cross low points in the crest, twenty-five to fifty feet lower than the general altitude of neighboring portions. The highest parts of the crest in Illinois, as noted above, are in northwestern Cook and southwestern Lake Counties, and stand about 900 feet above tide.

Surface Contours.—The Valparaiso morainic system presents notable variations in surface contour, even in the short section that lies within the State of Illinois. At the north, in Lake County, there are numerous basins occupying an area ranging from a few acres up to several square miles each, and containing lakes or marshes. They are scattered over the slopes of the moraine, indenting its surface to depths of twenty-five to fifty feet or more. Basins become rare upon passing southward into Cook County and the moraine is comparatively free from them throughout the remainder of its course in Illinois. The few which occur are very small and shallow. These basins, with their lakelets, add greatly to the beauty of the scenery of Lake County, furnishing attractive sites for summer residences and for camping grounds. Among the lakes there are knolls and irregular ridges, with gentle slope, ranging in height from ten feet or less up to about fifty feet. The moraine has also a well-defined crest line in a ridge twenty to forty feet higher than the border tracts and a mile or less in width, which leads southward, with a somewhat winding course, through the western part of Lake County, forming the water parting between Fox and Des Plaines Rivers.

Passing south into Cook County the crest line continues as definite as in Lake County. To the east of the crest line there are only gentle swells seldom more than fifteen feet in height and a rapid descent to the plain bordering the Des Plaines. To the west of the crest line there is an irregular network of ridges and knolls, inclosing winding sloughs. The height of these knolls and ridges ranges from ten or fifteen feet up to fully fifty feet. Continuing south across Du Page County the ridges tend to a parallelism with the crest and the sloughs become less conspicuous. This topography also characterizes the portion of the moraine in Will County. In the latter county the tendency to a parallel arrangement of the ridges and of chains of knolls is very marked. Throughout the course in Du Page and Will Counties the inner slope has a milder expression than the crest or outer slope, though the contrast is scarcely so striking as in Cook County.

The outlying belt in Will County carries low knolls twenty feet or less in height. There is not so well-defined ridging as in the main belt. Though the undulation is not sharp, it is sufficient to give this belt a strong contrast to the very smooth till plain which borders it on the south. The contrast with the till plain on the north is not so striking, for that plain is dotted with low swells ten feet or more in height.

Thickness of the Drift.—Situated as the Valparaiso moraine is in a district over which there have probably been several successive ice advances with intervening recessions, the drift can scarcely be expected to belong solely to the advance which formed this moraine. It is known that remnants of the partially cemented sheets of the oldest stages of glaciation are present. There is probably present also a considerable amount of drift of the Early Wisconsin stage. The drift of the Early Wisconsin stage is so similar to that of the Valparaiso moraine that it is doubtful if it can be readily distinguished from it. There does not appear to be a well-defined soil horizon at the base of the Valparaiso sheet to mark the line of junction such as occurs under wide areas at the base of the Early Wisconsin drift. The thickness of the Valparaiso drift sheet can perhaps be best estimated by the relief, for it can scarcely be assumed to exceed greatly the measure of the outer border relief of the moraine. The relief on that border is estimated to average about sixty-five feet. The average thickness is probably even less than the relief, since the sheet is markedly thinner on the borders of the moraine than on its crest.

The combined thickness of the several sheets of drift here represented is also difficult to determine from the fact that the underlying rock surface is very uneven. In Cook County alone the rock surface is known to range from about 100 feet above the level of Lake Michigan to more than 100 feet below the surface of the lake. In the table of thickness of drift which follows, the older deposits as well as those of the Valparaiso moraine are included.

List of deep borings along the Valparaiso Moraine in Lake, Cook, Du Page and Will Counties :

		Thickness of Drift.	Approximate Elevation above Tide.
1.	At Ivanhoe, on crest	290 feet	800 feet
2.	Near Lake Zurich, on crest	267+ "	900 "
3.	At Lake Zurich, 20 to 30 feet below crest	240+ "	880 "
4.	Hainesville, near crest	287+ "	880 "
5.	Gilmer, near crest	213+ "	820 "
6.	Crest, east of Wauconda	230+ "	850 "
7.	Crest, south of Barrington	315+ "	850 "
8.	Barrington, 40 to 45 feet below crest	254 "	818 "
9.	East of Elgin, near crest	220-240 "	850 "
10.	Palatine and vicinity	100-170+ "	750 "
11.	Near Schaumberg, along crest	190+ "	825 "
12.	Arlington Heights, about 150 feet below crest	128 "	700 "
13.	North of Arlington Heights, 20 to 30 feet above station	190 "	725 "
14.	Near Spaulding, about 50 feet below crest	120 "	770 "
15.	Bartlett, 10 to 20 feet below crest	100+ "	800 "
16.	Ontarioville, near crest	140+ "	815 "
17.	Roselle, about 50 feet below crest	100+ "	770 "
18.	Crest south of Bloomingdale	162 "	800 "
19.	Itasca	72+ "	692 "
20.	Bensenville	97 "	677 "
21.	Elmhurst	98 "	688 "
22.	Elmhurst Quarry	Trace	660 "
23.	Turner Junction	116 "	765 "
24.	Quarries near Naperville	Trace	700 "
25.	Crest east of Naperville	115+ "	740 "
26.	Downers Grove	113+ "	720 "
27.	Crest east of Downers Grove	159 "	750 "
28.	Near Clarendon Hills	160+ "	755 "
29.	Crest northwest of Lemont	150 "	740 "
30.	Crest of moraine east of Lockport	115+ "	725 "
31.	Near Spencer	81 "	710 "
32.	Crest near Frankfort	135+ "	780 "
33.	Hickory Creek, near Frankfort	Trace	730 "
34.	Sec. 13, Tp. 35, R. XII E	"	760 "
35.	Monee, on crest	180+ "	804 "
36.	Crest near Goodenow	112+ "	780 "
37.	Beecher	106+ "	720 "
38.	Sec. 11. Tp. 34, R. XIV E	106+ "	720 "
39.	Chicago Heights	30 "	690 "
40.	Quarry 1 Mi. east of Chicago Heights	Trace	665 "

Structure.—The drift of the Valparaiso sheet, together with that of the Early Wisconsin, which underlies it, consists mainly of a soft blue till, easily penetrated by the spade or auger. With the till there are local deposits of sand or gravel, which collect the water that supplies wells. There are also a few places in which the deposits of sand and gravel occupy nearly the entire drift section. In following the moraine through Northeastern Illinois there will be found occasional townships in which the till, which is a poor source for water because of its compact matrix, is not accompanied by a sufficient amount of sand or gravel to furnish water for strong wells, while in adjoining townships no difficulty may be experienced in obtaining water. It is more often found necessary to drill wells to great depths in eastern and northern Du Page, northwestern Cook and southern Lake Counties than elsewhere along the moraine in Illinois, many wells in that district being more than 150 feet in depth. In southern Du Page County, between the east and west branches of Du Page River, the drift to a depth of fifty to sixty feet or more (the depth reached by the deep wells) is mainly sand and gravel, this being an unusually gravelly part of the moraine. In Will County wells seldom reach a depth of 100 feet because of the abundance of water-bearing sand or gravel at less depth.

In collecting well records there is, I find upon examining my notes, a larger proportion showing exceptional than normal conditions, it being natural to pass over the usual section after it is once noted without collecting further records. This should be borne in mind when examining the specific well records given below. Scores of wells were found which show a section about as follows: At surface ten to twelve feet of pebbly yellow till, beneath which is a soft blue till extending to the water bed of sand or gravel at depths ranging from twenty-five feet to 150 feet or more. If a well is carried to a depth much beyond 150 feet it is usual to pass out of the blue till into a hard brown till, unless rock is reached. This hard till presumably belongs to one of the earliest invasions of the ice. In a few cases great depths of sand have been found beneath the blue till, as noted below. The sections of wells here given include the deepest which came to my notice.

S. J. Lewis, a well driller, of Elgin, Ill., reports a well about one mile east of Lake Zurich, in Lake County (in Sec. 20, T. 43 N., R. 10 E.), which has the following section:

1. Yellow, pebbly clay	12 feet
2. Grayish-blue, pebbly clay	88 "
3. Fine, gray sand	197 "
Depth	297 feet

Altitude of well mouth about 900 feet A. T.

Mr. Lewis reports three wells near Lake Zurich which obtain water in gravel beneath the blue till at 138, 140 and 150 feet, respectively. Near Hainesville, in Sec. 28, T. 45 N., R. 10 E., he reports a boring to have reached the bottom of the blue till at 120 feet. Below this till is sand for a depth of 167 feet. The sand yielded an abundance of water, but was too fine to be screened by the strainer and no well could be obtained. Near Gilmer, in Sec. 3, T. 43, R. 10 E., Mr. Lewis made a well which penetrates stony clays 120 feet and sand 93 feet, obtaining water in coarse sand at a depth of 213 feet. For a mile or more east of Gilmer wells are obtained in gravel beneath blue till at a depth of 75 to 100 feet, but occasionally the blue till extends to a depth of 160 feet. In Barrington Township, Cook County, T. 42 N., R. 9 E., wells usually penetrate soft blue till to a depth of 100 to 140 feet and occasionally 200 feet before reaching a water bearing gravel or a harder till.

Mr. W. Spumer, of Lake Zurich, who has had some experience in boring tubular wells, furnished the following section of his own well near Lake Zurich, in Sec. 17, T. 43, R. 9 E.:

1. Yellow, pebbly clay	10 feet
2. Grayish-blue, pebbly clay, about	130 "
3. Sand and blue, pebbly clay in alternate layers of various thicknesses	60 "
4. Sand, becoming coarse and gravelly at bottom	43 "
Depth	240 feet

Mr. Spumer reports that a boring at Ivanhoe, Sec. 22, T. 44, R. 9 E., strikes rock at 200 feet. A well three miles southeast of Wauconda, on the Fletcher Estate, Sec. 32, T. 44, R. 10 E., is reported by Mr. Spumer to have the following section:

1. Yellow, pebbly clay	12 feet
2. Gravel	2-3 "
3. Blue, pebbly clay, with sand pockets	100 "
4. Sand and reddish, pebbly clay, in alternate layers, each 10—15 feet	107 "
5. Whitish, sandy clay	4 "
6. Sand and gravel	3 "
Depth	230 feet

Mr. Spumer estimates the depth of the blue till along the divide between the Fox and Des Plaines Rivers in southern Lake County to be 125 to 150 feet and wells occasionally obtain water in gravel immediately beneath this till.

Mr. William McWendle, a well borer at Oak Glen, reports two wells at Barrington that strike rock at 254 and 250 feet, respectively. To a depth of about 160 feet in each well the drift is mainly a soft blue till. Considerable cobble was encountered at this depth. Below the cobble is a lighter colored clay harder and more pebbly than the blue clay and apparently belonging to an older drift sheet.

Mr. A. W. Van Dervolgan, of Batavia, reports the following section of a boring on the crest of the moraine south of Barrington, in Sec. 22, Barringtown Township, which is the thickest section of drift yet noted in the Chicago Area:

1. Yellow and blue, pebbly clays, about	160 feet
2. Quicksand, about	15 "
3. Reddish, pebbly clay, hard and dry, about	140 "
Depth	315 feet

The well was abandoned without reaching the bottom of the drift and a second boring was made only five rods distant from it, which furnishes a good supply of water at 170 feet.

Mr. M. Sneible, of Palatine, has found in his experience as a well borer that the yellow surface clays in the vicinity of that village vary in depth from six to fifteen feet and that the blue bowlder clay is 100 to 125 feet in depth. He usually finds sand or gravel beneath the blue clay and here obtains the wells, but occasionally a thin bed of cemented gravel is penetrated or limestone is entered just below the blue clay before obtaining a well. In several instances he has reached the bottom of the drift at 150 to 165 feet and in one place, near Palatine, at 100 feet. But it should be borne in mind that the surface elevation in the vicinity of Palatine is at least 100 feet below the crest of the ridge in Barrington Township. Mr. Sneible has found buried soil but once. This was near Arlington Heights, beneath blue bowlder clay, at a depth of seventy feet. The soil was underlain by a pebbly clay. It contained bits of wood and was of an offensive odor.

Mr. R. Ryan, of Bloomingdale, in an extensive experience as a well borer, has found a buried soil but a few times. He recollects its depth in but one instance, in a well in the northwestern part of Schaumberg Township. It occurs at 135 to 139 feet below the surface. It is of a brownish black color and has an offensive odor. It is overlain by blue bowlder clay and underlain by quicksand. Mr. Ryan and also other well borers have found wood and peaty deposits imbedded at slight depth beneath ponds. They are covered by swamp muck and pebbleless clays and have probably been buried in postglacial times. Mr. Ryan reports the soft blue till to have a depth of 100 to 140 feet in the vicinity of Bloomingdale, Schaumberg and Wheaton.

Mr. Diebold, a well borer at Downers Grove, reports a depth of 100 to 115 feet of blue bowlder clay in the vicinity of Downers Grove, Clarendon Hills and Hinsdale. Mr. Diebold furnished the following section of a well at a brick yard on the crest of the moraine three miles east of Downers Grove:

1. Yellow clay (pebbly)	7 to 8 feet
2. Grayish-blue, pebbly clay	112 "
3. Fine, blue sand	39 "
4. Limestone	40 "
Depth of drift	150 feet

Mr. Diebold has frequently found a blue sand beneath the blue bowlder clay in that vicinity, and if this is not present there is usually white sand or gravel beneath the blue clay and overlying the rock.

Borings near East Du Page River strike rock at 100 feet or less, and the sand and gravel which underlie the blue clay are but a few feet in depth.

The structure of the drift along the bluffs of the Des Plaines is well exposed at several points between Lemont and Joliet. There appears to be much more sand and gravel than is shown by well sections on the uplands. There is, however, considerable till exposed in the east bluff. Just below Lemont a blue till rests immediately on the limestone, but frequently in that locality there is sand or gravel at the base of the drift. In the west bluff, opposite Lemont, there are large accumulations of sand, gravel and cobble, in portions of which bowlders and bowlderets are imbedded, while in other portions assorting is quite perfect. There are also places where a very fine, partially cemented, sand, almost as fine as loess, caps the deposit.

In the portion of the moraine east of the Des Plaines River the yellow clay has a depth of about ten feet. It is underlain by a grayish-blue bowlder clay, which carries a sufficient number of water-bearing veins to furnish abundance of water for wells. There is less difficulty experienced in getting good wells at slight depth here than in the portion of the moraine west of the Des Plaines River. There are very few tubular wells and these seldom exceed seventy-five feet in depth, while the majority of those along the crest of the moraine have a depth of but forty to sixty-five feet. Consequently there is a less complete knowledge of the deeper structure of the drift than on the portion west of the Des Plaines River. The following represent the deepest wells of which sections were obtained:

At Beecher Station a well 106 feet in depth is principally in blue bowlder clay and obtains water in a gravel at the depth mentioned.

On the crest of the moraine at C. L. Pease's residence, one mile north of Goodenow, a well 112 feet in depth is in blue bowlder clay to the water-bearing gravel at bottom.

J. O. Piepenbrink, Section 11, Crete Township, has a well 106 feet in depth, which has the following section:

1. Yellow, pebbly clay, of reddish cast	20 feet
2. Grayish-blue, pebbly clay	85 "
3. Coarse sand	1 "
Depth	106 feet

Mr. Piepenbrink finds the blue clay less pebbly than the yellow clay and the blue clay varies greatly in hardness in different wells on his farm and also varies at different depths in the same well.

In the village of Crete nearly all the wells enter sand at slight depth, and cellars are frequently drained by boring a few feet in their bottoms to a dry sand, which absorbs their water. The following section of a well in Sec. 8, Crete Township, is representative:

1. Yellow, pebbly clay	15 feet
2. Blue, pebbly clay	8 "
3. Dry sand	12 "
4. Quicksand and water	17 "
Depth	52 feet

In some wells the sand lies within ten feet of the surface and has no blue clay above it.

The following sections of well borings near Spencer will illustrate the structure and show the general thickness of drift in that locality:

Section of well at elevator in Spencer—

1. Yellow, pebbly clay	12 to 15 feet
2. Blue, pebbly clay, hard and dry	50 "
3. Cemented sand	3 to 4 "
4. Quicksand	5 to 6 "
5. Limestone at 75 feet (1)	

Section of well two miles south of Spencer—

1. Yellow, pebbly clay	8 feet
2. Sand and gravel	14 "
3. Blue, pebbly clay, hard and dry	60 "
4. Limestone at 82 feet	

Carbonic acid gas has been encountered quite frequently in wells along this moraine. It is usually found in dry cavities in the blue clay and is struck at various depths.

In the outlying belt in Will County, from the Des Plaines River southeastward, the thickness of the drift is much less than in the main belt, being as a rule between forty and seventy-five feet. There is usually at surface ten to twenty feet of yellow till. Beneath this is occasionally found a bed of sand or gravel of slight depth, but usually blue till immediately underlies the yellow. In the blue till beds of blue quicksand are often struck. These beds are, in this district, sometimes ten feet or more in depth, and offer great obstruction to well-digging or boring. Such quicksand is not uncommon in other districts in Northeastern Illinois. Wells are seldom obtained in it, though it is full of water, for the reason that the sand clogs the strainer of the pump. It is also difficult to case or wall a bored or dug well in this material, it being necessary to sink the wall or casing to the bottom of the sand. Many wells are carried through this sand and a few feet of the underlying blue clay to a gravel bed or in some instances into underlying limestone.

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(1) It is thought that rock was struck at the bottom of the well.

FLOWING WELLS (1).

Palatine Flowing Well District.—In the vicinity of Palatine, in northern Cook County, there is a small district having a radius of about two miles from the village of Palatine as a center, where flowing wells are obtained. In 1887 there were eight of these wells in the village of Palatine, and at least twenty-five in the township. The writer has obtained no later information concerning this district. The depth of the wells ranges from 70 to 170 feet, the majority of them being from 125 to 170 feet in depth. Occasionally a well has struck two or more veins from which water will flow, though usually there is but one vein. The water rises in the village of Palatine from the three strongest wells about ten feet above the level of the track at the depot. These wells do not obtain water from exactly the same depth, but are among the deepest wells in the village. The head is lower in the shallow wells, water rising in some cases only about five feet above the level of the railway station. It was not determined to what height water rises in wells outside the village compared with those in the village, since they are scattered widely and no levelings have been made between the wells. The rate of discharge varies greatly even in the village of Palatine. The strongest well, which is at the cheese factory, has a discharge of sixty gallons per minute. The other wells in the village flow but one to six gallons per minute, and the wells at the farm houses outside the village seldom flow more than five gallons per minute. The water is slightly chalybeate in every well which was examined. The waters vary greatly in hardness in the different wells. All the water, however, is so hard that it is necessary to "break" it before using it for laundry purposes.

There are many deep wells in the vicinity of Palatine which do not flow, even when the surface level is lower than that at the flowing wells. The water supply is apparently from veins whose collecting areas vary in altitude, otherwise the water level would be more uniform.

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(1) These flowing wells were first discussed by me in the 17th Annual Report of the U. S. Geological Survey.

The collecting area is thought to be in the portion of the moraine west and north of Palatine. The moraine west of Palatine attains an altitude of 100 to 120 feet above the station, and the crest in Lake County has nearly as great an altitude. The superficial drainage is very poor north of Palatine, on the divide between Salt Creek and Buffalo Creek, and it is also poor west of Palatine, for there is no stream nearer than Fox River to receive its waters. Consequently much of the water must evaporate or find outlet by underground passages. There seems to be a sufficient collecting area and also a sufficient variation in altitude to account for the wells and the difference in head.

Salt Creek Flowing Well District.—South of Palatine Township, along Salt Creek and its tributaries, flowing wells are frequently obtained. They differ but little from springs which occur along the creek. There are at least six such wells along a tributary of Salt Creek in the eastern part of Schaumberg Township (T. 41, R. 10 E.), none of which exceed forty-five feet in depth. Those along Salt Creek, from Plum Grove, in southern Palatine Township, to the vicinity of Elmhurst, in York Township, seldom exceed thirty feet in depth.

In Itasca there are a few flowing wells along a tributary of Salt Creek. Of these the deepest one recorded is but twenty-eight feet. The water here will rise not more than three feet above the bed of the creek. This level is sixty-five to seventy feet lower than the level of the flowing wells in Palatine.

OUTER BORDER PHENOMENA.

While the ice sheet was forming the Valparaiso moraine there were streams of water issuing from its outer border and escaping down the Des Plaines River. These streams became overburdened with material derived from the ice and in consequence built up their beds and valley bottoms to a marked degree. The filling reached such a stage that the streams were in some cases forced to find outlet across the present interfluvial tract. Valleys were formed by these streams which are now abandoned or occupied by insignificant brooks (1).

From the contour maps prepared by the United States Geological Survey it is possible to ascertain the height to which the filling extended along the lower part of the Du Page and the Des Plaines and the elevation of these abandoned channels. From

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[1] Perhaps the valleys here referred to were partially opened by subglacial streams at the time when the moraine which they cross was occupied by the ice sheet.

the Joliet sheet, which includes sections of the Des Plaines and lower Du Page Rivers, immediately outside the Valparaiso moraine, it appears that on the immediate border of the moraine the gravel filling reached an altitude approximately 620 feet A. T. These gravel deposits are extensive along the Du Page River below the junction of the West and East Forks and along the Des Plaines River below Romeo. Tracing these deposits southward, there is a marked descent, the altitude at Plainfield being scarcely 610 feet, at Grinton 590 feet, at Joliet Mound 580 feet and at Channahon 570 feet, a fall of fifty feet in a distance of about twenty miles.

The abandoned valleys which connect the Des Plaines and Du Page Rivers are not of the same elevation. The northermost one, occupied by small streams which drain it in opposite directions, each of which is known as Isle la Cache Creek, leaves the Des Plaines opposite Romeo and passes nearly directly westward to the Du Page Valley just above Plainfield. It has an elevation between 600 and 610 feet A. T. It opens out toward the southwest into an extensive gravel plain near Plainfield, having the same elevation as the channel, which was probably built up in part by the current which formed this valley. The valley is about one-half mile in width and is cut to a level forty to fifty feet below the bordering uplands.

A second valley leaves the Des Plaines about two miles south from the Isle la Cache and leads southwestward to the Du Page, entering that valley below Plainfield. Its elevation is 620 feet, or about the elevation of the gravel deposits bordering that portion of the Des Plaines Valley and somewhat higher than the deposits on the Du Page. It is not so large as the Isle la Cache and probably was earlier abandoned.

A third valley leaves the Des Plaines about midway between Lockport and Joliet and passes westward into the Du Page Valley just above Grinton. The elevation of its channel is 570 to 580 feet or ten to twenty feet below the level of the bordering gravel deposit. It is about fifty feet in depth and nearly one-half mile in width. The contours of its bluffs indicate the line of a vigorous stream. This valley was apparently the last of the three to be abandoned.

The deposits along the Du Page and Des Plaines Rivers consist in the main of coarse gravel and cobble, much of the finer material having been swept away by the strong current. Excellent exposures are to be seen in the gravel pits near Plainfield on the

Du Page and in numerous small gravel pits along the border of the Des Plaines, both above and below Joliet. One of the largest on the Des Plaines is found in an island-like remnant of the old terrace known as "Joliet Mound," about two miles below the city of Joliet, on the west side of the river. At the southeast end of this mound the following section is exposed:

1.	Surface coating of silty clay	1 to 4 feet
2.	Coarse gravel and cobble	10 to 12 "
3.	Sandy gravel of medium coarseness, cemented in places.	25 to 30 "
4.	Fine sand or loam	4 "
5.	Blue, pebbleless clay, laminated, calcareous	8 to 10 "
6.	Bowlder bed, containing clay balls and a sandy, clay matrix, extending to river level on east side of mound, but underlain at slight depth by limestone at west side.	5 to 20 "

It is thought that the bowlder belt is a result of interglacial erosion of a till sheet. The blue pebbleless clay which overlies it is apparently a still water deposit formed perhaps before the ice sheet had reached such a stage of melting as to produce vigorous drainage. The upper member appears to indicate a deposit by a stream whose vigor was greatest toward the close of deposition, for at the top the cobble is swept almost free from sand. The change, however, may have been brought about by a shifting of the main current of the stream, the coarse material being deposited over portions of the bed which had before been outside the main current.

The deposits of gravel along this valley terminate very abruptly at the south, near Channahon, there being only a fine sand on the plain in the Morris basin at the head of the Illinois. This feature is apparently due to the presence of a body of still water in the low country about the head of the Illinois River. The region is covered by sandy deposits up to a level about 575 feet A. T., on the border of which there are in places well defined beach lines. This lake had a western outlet through the Marseilles moraine down the Illinois. Its beaches are traceable a short distance beyond Morris. Further west the body of water became narrowed to the width of the Illinois valley and changed to an eroding agent.

It is probable that each of the small tributaries of the Kankakee, which head in the Valparaiso moraine, and also eastern tributaries of the Des Plaines, were lines for escape of glacial waters, but the writer has not examined the valleys to determine the effect of such waters, excepting the valley of Hickory Creek, which enters the Des Plaines at Joliet. This valley has a moraine-headed terrace, setting in at the outer border of the moraine in Sec. 17, New Lenox Township. It has a gently undulating surface for a mile or more out from the border of the moraine; its surface then becomes plain. This gravel plain is nearly as high as the bordering till plains 620 to 630 feet A. T. and 60 to 70 feet above the present stream.

On the east side of the West Du Page River, from Naperville northward, the gravelly deposits of the moraine graduate into terraces or gravelly aprons, which lead down the valley. The low gravelly knolls of the moraine disappear in a nearly plane surfaced apron on descending to the border of the river. This gravel apron is not so extensive as the deposits of the lower Du Page, above described, and is now seen only as remnants along the valley border.

The East Du Page throughout its entire length drains a broad slough, which separates morainic ridges. Its bottom is said to be underlain by deposits of gravel and cobble.

LAKE BORDER MORAINIC SYSTEM.

THE MORAINES.

Between the Valparaiso moraine and the shore of Lake Michigan there are, in Cook and Lake Counties, a series of nearly parallel till ridges. We can perhaps best describe them as the West Ridge, Middle Ridge and East Ridge. Though usually distinct, the ridges are in places coalesced as described below.

The Outer or West Ridge.—The outer or west ridge enters Illinois from Wisconsin on the west side of the Des Plaines River, its outer border being for a few miles followed by Mill Creek, while its inner extends to the west bluff of the Des Plaines River. Just below Gurnee the river passes through the moraine and for several miles south follows closely the outer border. The river then bears away from the ridge a short distance and the outer border of the ridge for the remainder of its course lies a mile or more east of the stream. In Lake County the ridge is sufficiently prominent and bulky to constitute a marked feature and has a general width of about two miles. In the south part of the county it sends out a spur to join the middle moraine belt near Deerfield, while the main ridge continues south into Cook County, gradually decreasing in strength and dying out in a plain near Mont Clare, in the southwestern part of Jefferson Township (T. 40, R. 12 E.). For five or six miles north from its southern terminus it rises scarcely ten feet above the bordering plains, and is distinguishable from them mainly in being more undulatory. Where well developed, as in northern Lake County, the moraine has numerous knolls, 20 to 25 feet in height, and these stand upon a basement ridge whose relief is nearly twenty-five feet. A noticeable feature of this and also of the other ridges of this system is the difference in the breadth of the outer and inner slopes, the usual breadth of the outer slope being scarcely one half that of the inner.

The Middle Ridge.—As already noted, this ridge is joined to a spur from the west ridge, south from Deerfield. The combined belt finds its southern terminus near the head of the Chicago River and at the border of the old lake. A possible continuation southward is discussed below. The course of the belt is south to north, through Northfield Township, Cook County. Upon entering Lake County it becomes distinct from the spur and remains a distinct ridge for a distance of fifteen miles. It there, in Sec. 18, Waukegan Township (T. 46, R. 12 E.), becomes united with the east ridge and remains so as far north as it has been examined. On each side of this ridge there is a narrow sag or slough. The sag on the east is marshy its entire length from Winnetka, in Cook County, northward to the latitude of Waukegan, a distance of nearly twenty miles. For a couple of miles at its southern end it has a width of one-half mile or more, but the usual width is only one-fourth mile. The sag on the western, or outer, border contains a marsh from Rondout station south to the Lake and Cook County line, a distance of about nine miles.

This ridge, like the west ridge, has low knolls along its crest, 8 to 15 feet in height, but the coalesced ridge in Northern Cook County is more billowy and carries knolls twenty feet or more in height. There are basins and winding sloughs among the knolls, which add to the expression of the moraine.

The East Ridge.—The southern terminus of the east ridge is at Winnetka, where the present lake cuts it off. It has apparently had its entire east slope and a portion of the crest removed by the lake, there being a descent immediately from the bluff on the lake to the slough, which lies west of the ridge. Following the ridge north to Highland Park the crest and east slope appear. Continuing north to Lake Forest, a narrow till plain appears on the east of the ridge, the inner border of the ridge lying back a half mile or more from the lake front. Still farther north at Waukegan, the inner border lies back about two miles from the lake front. The usual width of this ridge, where complete, is about one mile. The crest of the ridge usually stands 110 to 125 feet above the lake. At Winnetka, the higher portion being removed, it rises but 80 feet above the lake. The till plain east of the ridge stands 75 to 90 feet above the lake.

The rate at which the lake bluff is being encroached upon by wave action has become a matter of much concern to the residents. It is estimated by old settlers that from Waukegan to Evanston there has been, during the thirty years from 1860 to 1890, a strip about 150 feet in width, undermined and carried into the lake. This amounts to about 500 acres, representing at present valuation nearly one million dollars' worth of property.

Relief.—The west ridge rises with a somewhat abrupt slope about twenty-five feet above the plain along the Des Plaines River. On the inner (eastern) side there is a gradual descent of about forty feet to the plain along the Chicago River, and of 20 to 25 feet to the marshy plain in Lake County.

The middle ridge has a relief of 20 to 25 feet above the marshy plain on its outer border, and a gradual slope of 25 to 40 feet to the sag or slough, which lies on its inner border.

The east ridge has a relief of 20 feet in Northern Lake County and 35 to 40 feet in Southern Lake and Northern Cook Counties above the sag on its outer border. The reliefs of all these ridges are lessened at the northern end because of increase of elevation in the sags or plains which separate them. The ridges each maintain a nearly uniform height above Lake Michigan throughout their course in Illinois.

Thickness of Drift.—In numerous borings, 75 to 100 feet in depth, no rock is struck and no outcrops of rock occur along this portion of the lake shore. The drift beneath the level of the base of these moraines is probably largely of earlier date. The following list of borings which have struck rock indicates that in several places at least the rock surface lies much below the surface of Lake Michigan.

1. At Senator C. B. Farwell's artesian well, in Lake Forest, rock is struck at 160 feet. The well mouth is 40 to 45 feet below the crest of the east ridge at Lake Forest and about 75 feet above Lake Michigan.

2. At Highland Park rock is struck at 160 to 175 feet. The elevation above the lake is 100 to 115 feet.

3. At Lloyd's artesian well, in the north part of Winnetka, rock is struck at 150 feet. The well mouth is by surveyors' level 78 feet above Lake Michigan.

4. At Ravinia a well strikes rock at 164 feet. The surface level has not been accurately determined, but it is probably about 100 feet above Lake Michigan.

5. Near Schermerville rock is struck at 147 feet. The surface elevation does not exceed 100 feet above Lake Michigan.

6. On the crest of the west ridge in Sec. 14, Maine Township (T. 41, R. 12 E.), rock is struck at 110 feet. The elevation is probably about the same amount above the lake.

Structure of the Drift.—Along the lake shore the bluffs from Winnetka to the vicinity of Waukegan rise abruptly 75 to 90 feet and present many good exposures of the drift to this depth. There is at the surface a pebbly yellow clay 8 to 13 feet in depth, which is similar to that in the Valparaiso moraine. Beneath this clay is a grayish blue till containing occasional sand pockets saturated with water. These, however, form but a small part of the drift. The bulk of the bluff is a compact till, but moderately pebbly and exposing only an occasional imbedded bowlder. It was noted that the pebbles and bowlders are usually glaciated.

Neither the east ridge nor west ridge nor the northern portion of the middle ridge has gravel knolls of any consequence, but the southern portion of the middle ridge lying in Cook County has many such knolls. Indeed, nearly every prominent knoll contains gravel. It seldom exceeds 15 feet in depth and appears to be confined to the knolls, for they are situated on a basement ridge of till similar to the till exposed along the lake bluff. But one complete reliable section of the drift could be obtained, which, though valuable, needs to be supplemented by other records to furnish a satisfactory knowledge of the lower portion of the drift. The well is located at Ravinia. Its section was furnished by William McWendle, of Oak Glen.

1. Pebbly, yellow clay	11	feet
2. Grayish-blue, pebbly clay	60	"
3. Gray clay, very pebbly	10 to 12	"
4. Grayish-blue, pebbly clay, lighter color than No. 2	70	"
5. Clay, resembling putty	4 to 5	"
6. Limestone	22	"
Total drift	164	feet

SUPPOSED CORRELATIONS.

None of these moraines have been found to have connection at their southern end with the massive Valparaiso moraine, nor do they admit of continuous tracing around the southern end of the lake within (north of) that moraine. The weak development in that district seems the more remarkable since there is on the east side of Lake Michigan, northward from Porter County, Indiana, a series of ridges of similar size and complexity to that under discussion and which are probably its continuation. The conditions which affected the southern end of the ice lobe at the time these belts were forming are so poorly known that it may be difficult to ascertain what caused this wide gap. The question naturally arises whether the expanded lake and its old outlet may not have removed the ridges.

In the case of the western ridge this suggestion is inapplicable, since the terminus at Mont Clare is outside the well-defined beaches and above their level. The ice sheet here, however, may have terminated in water held between its front and the Valparaiso moraine in the brief period required for the cutting down of the outlet to the level of the upper beach. But in that case, while wave action may have removed weak morainic features, it seems scarcely probable that there could have been a complete obliteration of so strong a belt as is present in districts to the north. In the case of the Middle and East Ridges, as shown below, there may have been some erosion by the lake outlet and lake waves.

The Blue Island Ridge.—The Middle Ridge has its southern terminus as a well-defined ridge at the point where it meets the Upper beach. There is, however, near the southwestern limit of the city of Chicago a till ridge, and connected with it a bowlder belt, which may be correlatives of this morainic ridge.

The till ridge referred to is known as "Blue Island." It leads north to south for a distance of about six miles, along the line of Calumet and Worth Townships. Blue Island village is situated at its southern end. At that end the ridge stands about 60 feet above Lake Michigan, but rises northward to an altitude 85 to 90 feet above the lake. Its width, including the slopes, is only about one mile. The northern portion is gently undulating and is strewn with bowlders, but the remainder of the ridge is smooth and comparatively free from surface bowlders. Around this ridge there are shore marks in the form of eroded banks or terraces and gravelly beaches at an altitude 55 to 60 feet above the present lake level. On its west border sand from the old lake shore is drifted into dunes that extend nearly to the top of the ridge. Blue Island ridge owes its elevation to a thickening of the drift deposits, for the rock surface is as low beneath it as on border plains. A well at Morgan Park, near the crest, reaches a level 70 feet below the base of the ridge before entering limestone.

Bowlder Train.—A train of bowlders is traceable north from the north end of Blue Island through the western part of the city of Chicago to the vicinity of the Chicago River in Jefferson Township. Although portions of the line fall within a thickly settled portion of the city, the bowlders still remain in sufficient numbers to be a noticeable feature. In the thinly settled district from South Lynne southward to Blue Island they remain in about their natural abundance. The belt occupied by the bowlders is a mile or more in width. There appear to have been several hundred bowlders to the square mile along this line, while on bordering districts there are estimated to have been less than 100 to the square mile. From the north end of this bowldery tract to the south end of the

Middle Ridge the interval is but a few miles and is mainly covered by heavy deposits of lake sand and gravel which would obscure any bowlder connection which may have existed. There seems, therefore, nothing to oppose the correlation of the bowlder train and Blue Island ridge with the Middle ridge.

From the south end of Blue Island ridge to the till ridges in Porter County, Indiana, no line of bowlders or indication of the position of the ice margin has been found. Such features may however, be concealed in much of that district by the heavy deposits of lake sand.

Continuation of East Ridge.—The East ridge apparently had some continuation southward beneath the present lake. Prof. L. E. Cooley, of the Chicago Drainage Commission, informs me that in a series of dredgings in the south end of the lake, made a few years since under his direction, a bowldery belt was traced for several miles southeastward from the terminus of the East ridge at Winnetka. This bowldery belt is perhaps a residue from a ridge of till which has been cut away by the lake.

ASSOCIATED TILL PLAINS.

The ridges just discussed occupy but a small portion of the area embraced between the Valparaiso moraine and the shore of Lake Michigan. The greater part of the area is a plain underlain by till deposits. On this plain, as is shown later, the lake has built or carved its shore lines and made thin deposits of sand or gravel.

Altitude and Slopes.—In the portion of the plain west and south from Chicago the altitude at the border of the Valparaiso moraine is 620 to 630 feet A. T., or 40 to 50 feet above the lake. From this border there is a gradual descent toward the present shore of Lake Michigan, where the altitude is about 590 feet A. T. This portion of the plain was covered by the lake at the time the upper beach was formed, the altitude of that beach being 635 to 640 feet A. T.

Upon passing northward along the till plains just described the narrow plains which separate the ridges soon rise above the level of the Upper beach. The plain that lies between the West ridge and the Valparaiso moraine slopes eastward at the rate of several feet per mile. Its west border next the Valparaiso moraine rises from 635 feet at Ovington station, on the Omaha division of the C. & N. W. railroad, to about 690 feet at the line of Cook and Lake Counties, a distance of 18 miles, and about 725 feet in northern Lake County at the line of Illinois and Wisconsin, a distance of 24 miles farther.

This rise of 1½ to 3 feet per mile is, of course, not perceptible to the eye.

The plain between the West and Middle ridges rises from 630 feet at Oak Glen to 680 feet at Deerfield, a distance of six miles. From Deerfield north to the State line, a distance of 24 miles, it is shown by the C., M. & St. P. railway survey to stand at 670 to 685 feet A. T. Russell station, near the State line, is 673 feet.

The plain between the Middle and East ridges rises from 630 feet opposite Winnetka to about 670 feet at the point where the ridges unite, 20 miles north from Winnetka.

Thickness of Drift.—On this plain there is much difference in the thickness of the drift and since the surface, aside from the till ridges just described, and the low beach lines, has very little variation in altitude, the difference in depth is due almost entirely to the variation in surface of the underlying rock strata. Within the city of Chicago, where the surface is especially flat, several rocky prominences come to the surface, or are concealed but slightly by drift, while among them the drift accumulations extend to depths of 100 to 125 feet or more (1).

Mr. Samuel G. Artingstall, while City Engineer, prepared a map of the city giving the distance to rock at many places. This indicates that a filled valley with rock floor 100 to 125 feet below lake level passes through the north central part of the city, entering the lake south of Lincoln Park.

West from the city the rock rises over quite extensive areas very nearly to the surface of the plain, or to a height of 30 to 60 feet above the level of Lake Michigan. On the border of the Chicago outlet there is a nearly continuous exposure of rock from near Summit to the head of the Illinois.

In the northern portion of the district, between as well as beneath the till ridges, the rock surface has an average altitude slightly lower than in the low plain in the vicinity of Chicago, for the majority of the wells go about 50 feet below the level of Lake Michigan before entering rock. It is estimated that the thickness of drift in this northern portion will average nearly 150 feet, while in the low plain the average will scarcely exceed 50 feet.

Structure of Drift.—The drift beneath this plain, like that of the moraine, consists largely of a soft blue till beneath which are remnants of a hard till of earlier age. The tills appear to be of

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[1] A large amount of material has been collected by the Geological and Natural History Board of The Chicago Academy of Sciences, with a view to preparing a topographic map of the rock surface underlying the city and border tracts, and which is designed to be published as a bulletin of the Academy.

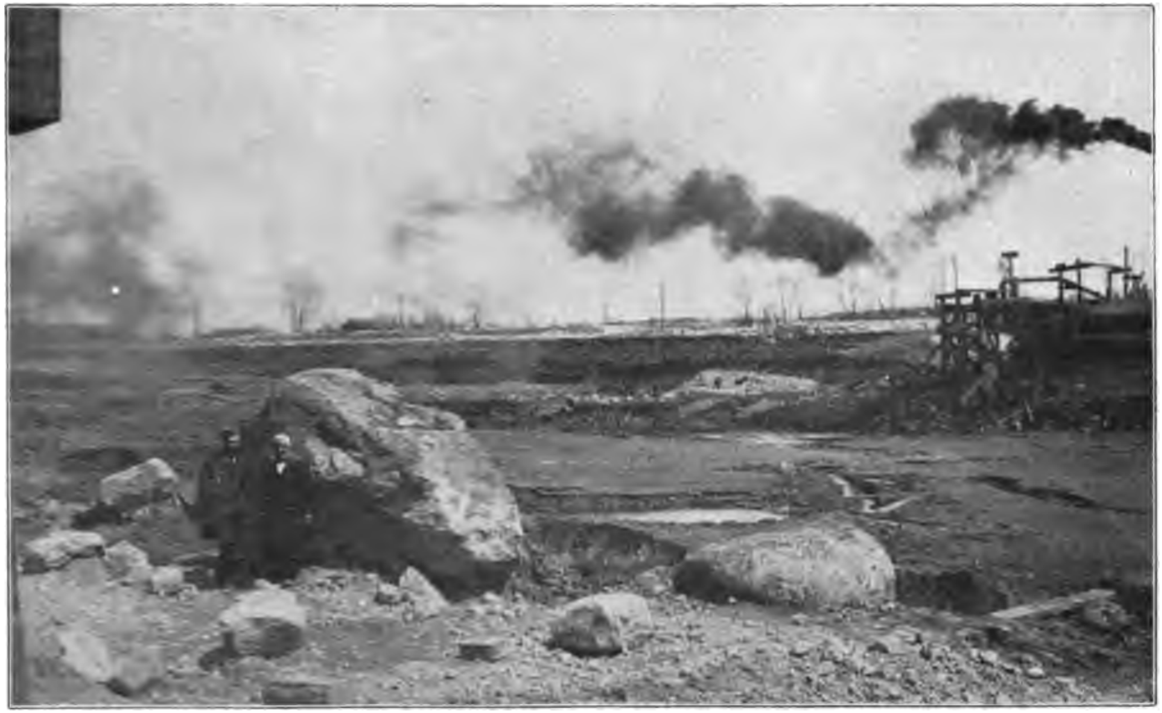

Fig. 1. Exposure near Willow Springs, made by Chicago Drainage Canal, showing large bowlders below a bed of peat. The outcrop of peat may be seen in the edge of the bank back of the bowlders. [Photograph by the Chicago Drainage Commission.]

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direct glacial deposition even in portions of the plain which lie within the limits of the beaches. The clayey matrix of the soft till is scarcely so thickly set with stones as that of the underlying hard till. In both tills many of the stones are glaciated. The rocky constituents grade from bowlders two to three feet or more in diameter down to minute pebbles. These in the upper or later till are made up in large part from the local Upper Silurian rocks, probably less than 10 per cent. being from the pre-Cambrian Canadian rocks. Devonian rocks from ledges to the north of Chicago are sparingly represented. The clayey matrix is highly calcareous and under the microscope it is found that angular or but slightly rounded grains of limestone constitute a large proportion of the fine material. With the minute limestone fragments, there appear quartz grains, bits of shale and fragments from crystalline rocks of various kinds. Whether the rock constituents of the lower till differ markedly from the upper has not been ascertained. Its situation immediately upon the Niagara limestone would in all probability result in the incorporation of an even larger proportion of this rock than appears in the upper till.

One of the most conspicuous instances of the occurrence of the lower till within the Chicago area is that brought to light in the excavation of the Chicago Drainage Canal. Immediately east from Summit the canal for a mile or so extends a few feet into a very hard, partially cemented till apparently of early glacial age. Its hardness compared with that of the overlying till is so marked that the contractors who engaged to excavate this part of the channel were obliged to abandon the steam shovel which had been used in the soft till and resort to blasting. It is probable that this old drift fills depressions in the rock quite extensively in this district, but as no special attention has been given its identification the instances recorded are not numerous. The well drillers usually recognize the hard till and apply to it the term hardpan, while the soft till is called clay.

Although the great body of the drift is till, there are found numerous thin beds of sand or gravel in which water collects in sufficient quantity to supply the wells. There are also small pockets of dry sand or gravel occupying but a few cubic feet each. Such pockets were found in the excavation of the main lake tunnel for water supply. They were in some cases completely inclosed by till.

On the surface of the plain both above and below the level of the upper beach there is quite generally present a clay, varying in thickness from a few inches up to several feet, in which pebbles are far less numerous than in the till. It however carries occasional bowlders. This deposit seems attributable to the combined agency of water and ice. It was probably a deposit made in a body of water held between the ice front and the Valparaiso moraine while the ice sheet was still in the immediate neighborhood of the moraine.

In the district within the limits of the upper beach there are deposits of sand and gravel marking the shore lines of the lake. These deposits form a less regular coating than the clay just mentioned. Over much of the plain the deposition was so light as to leave scarcely a trace of sand in the soil, but in places the deposits cover the till of the old lake bottom to a depth of 20 to 25 feet. The heavy deposits are found chiefly along the present lake border from Evanston southward, where there is a continuous belt of sand ranging in width from one-half mile to three or four miles, and having an average depth of not less than 10 feet. The southwestward lake outlet appears to have carried away much of the sand which was brought into the southern end of the lake while that outlet was open.

The depth of leaching and oxidation is markedly less on the plain covered by the lake than on the till ridges or the Valparaiso moraine. Numerous tests with hydrochloric acid show the leaching on the plain to extend only to a depth of a few inches, seldom more than two feet, while on the ridges it is rare to obtain a response at less than five or six feet from the surface. On the plain the surface oxidation of the till is only two to six feet, while on the ridge it is six to ten feet or more. This difference in the amount of oxidation and leaching is probably attributable in part to the flatness of the plain and in part to the later date at which the plain was exposed to atmospheric action.

There have been several deep lines of excavation made in Chicago and vicinity which have afforded excellent opportunities for studying the structure of the drift. The longest line is the drainage canal, now under construction, which opens a channel 25 to 40 feet in depth from the Chicago River at Bridgeport to the Des Plaines River at Summit, that is entirely in drift. Along the Des Plaines also the excavation is largely in drift to the vicinity of Lemont, where the canal becomes a rock channel. From Bridgeport to Summit there is little besides till, but from Summit to Lemont gravel, sand and the coarser material deposited along

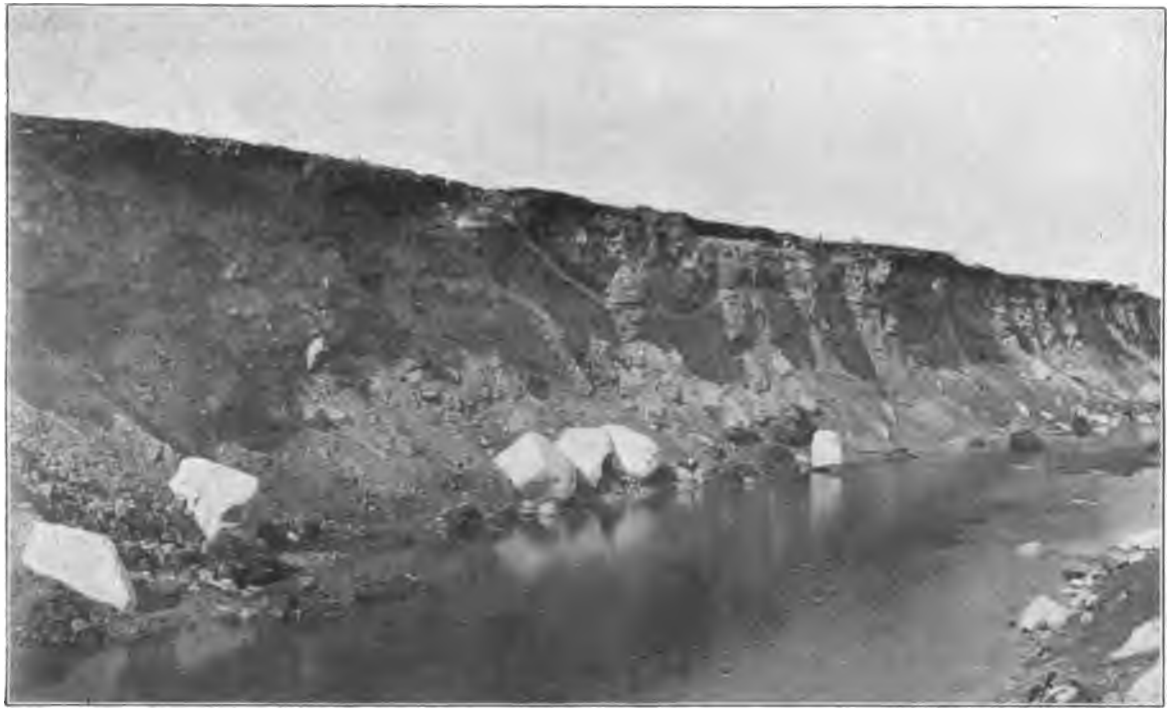

Fig. 2. Exposure showing variability in coarseness and in dip of beds in the Chicago outlet near Willow Springs. [Photograph by the Chicago Drainage Commission.]

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the line of the old outlet form a large part of the section. (See Figs. 1 and 2.)

In the Fullerton avenue conduit which leads eastward into the lake through the north part of Chicago the drift is mainly till, but the surface sand is a conspicuous deposit. From its western end to within 2,000 feet of the lake the rock surface is found at a depth of 43 to 54 feet. Within 100 feet east from this point it drops down to 80 feet, passes below the conduit, and does not appear further east. The sand has its greatest thickness at about 1,700 feet from the lake, where it reaches 25 feet. It decreases westward to 17 feet at 2,100 feet from the lake, and to 12 feet at 6,000 feet, and entirely disappears before reaching the Chicago River valley. Toward the lake shore also it decreases, being about 18 feet in depth for 1,400 feet west from the shore. At the water's edge the depth is but 10 feet. The profile continues out 1,100 feet below the lake, and there is but three feet of sand at its terminus.

The profile of the lake tunnel shows the rock to be at a depth of 37 feet at the working shaft four miles inland. Eastward from here the distance to rock gradually increases to a point about two and four-tenths miles from the lake shore, being between 50 and 60 feet at that point. It there drops down rapidly to a level nearly 90 feet below the surface, and is not encountered farther east. For two miles out beneath the lake the excavation reaches 60 feet or more below the lake bottom. The tunnel was through till its entire length. It shows, as noted above, pockets of sand inclosed in the till. The surface sand, as in the Fullerton avenue conduit, is of considerable depth.

In Hyde Park Township in the south part of Chicago numerous borings and excavations show the sand deposits to be from five feet up to about 20 feet in depth. Except where the rock comes near the surface till is found to underly the sand.

STRIAE.

Exposures of striae are numerous and indicate that the axial movement of the ice sheet in this district was decidedly west of south rather than due south. This should be borne in mind in estimating the amount of divergence in the lateral flowage. The striae in this region are remarkably well preserved, and that, too, where conditions for obliteration seem favorable. In some places there appears to have been no drift protecting the ledges since the withdrawal of the lake, if not since the time when the ice sheet withdrew, and yet but few exposures do not preserve the striae. In similarly exposed situations outside the Valparaiso moraine striae are seldom preserved. This difference may be due partly to the greater age of the striae outside the moraine. But aside from this there appears to have been an original difference in the intensity of glaciation by which ledges more often escaped the rasping action of the ice sheet outside the moraine than in the district between the moraine and the lake.

The following embrace the localities where bearings were observed:

1. Stony Island in south part of Chicago. The rock where glaciation was observed dips toward the southeast, with an angle of nearly 40 degrees, and heavy scorings follow the line of strike, with a bearing S. 44 degrees W. (See Fig. 5.) Associated with these are striae of feebler development, which vary in direction fully 10 degrees to the east and west of the heavy scorings, thus ranging from S. 34 degrees to S. 54 degrees W. An escarpment of the dipping layers rising about six feet above the remainder of the quarry is glaciated not only on the upper surface and nearly vertical front, but also beneath one of the lower layers, its dipping under surface being smoothly polished for about 18 inches back from the front of the ledge. (See Fig. 4, where the glaciated under surface appears near the sachel.)

2. On Thorn Creek near Thornton. The prominent portions of arching layers of the Niagara limestone are roche moutonneed and a few striae have a bearing S. 31 degrees W.

3. Quarries one mile southwest of Blue Island. A few faint striae were observed bearing S. 54 degrees W.

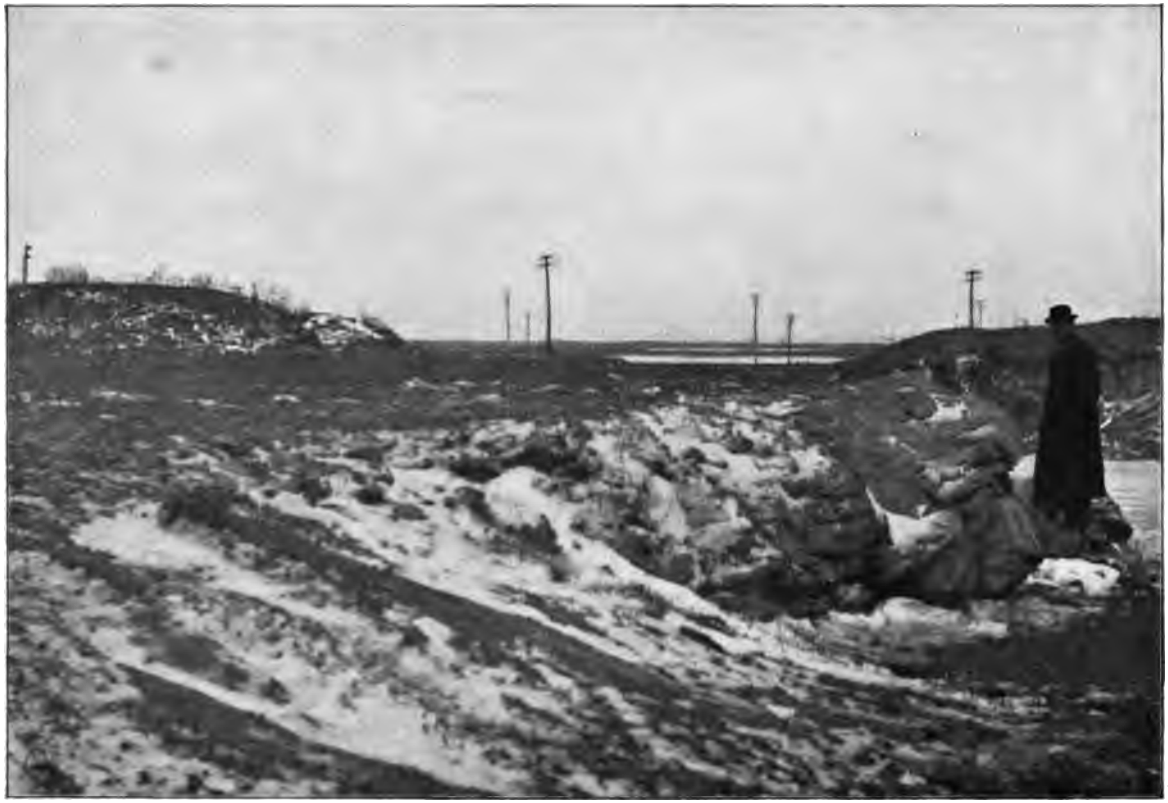

Fig. 3. Long range view of an outcrop on "Stony Island," in Chicago, which has been striated on face and under surface as well as on top. [Photograph by Gayton A. Douglass, March, 1897.]

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4. On west side of Des Plaines River, one-fourth mile north of Santa Fe Railway bridge. An area of several square rods of limestone surface is heavily glaciated. Grooves one-half inch in width are common and there are a few fully two inches in width. Fine lines are numerous. The bearing corrected for magnetic variation is very nearly due west, the magnetic bearing being 3 to 4 degrees south of west. This striated surface slopes perceptibly toward the southeast, there being a descent of 2 to 3 feet in as many rods. The glaciation was therefore made on an ascending surface.

5. Immediately west of Summit on the west side of the Des Plaines. The striae here observed are faint lines bearing S. 38 degrees W.

6. Between Willow Springs and Sag bridge, in the bed of the Drainage Canal. The striae here observed consist of faint lines bearing S. 23 degrees W. They appear over a space of several square yards. (See Fig. 6.)

7. At Lemont, about 500 feet from the Santa Fe Railway bridge. Mr. Ossian Guthrie reports that heavy grooves have a bearing about S. 60 degrees W. They were exposed in the excavation for the diversion channel for the Des Plaines. A view of these grooves is given in Fig. 7, but the present writer thinks they may be the product of the waters of the Chicago outlet rather than glacial striae.

8. Lyons, quarry in south part of village. Nearly all the striae bear S. 70 degrees to 75 degrees W., but scattering striae range from S. 44 degrees to S. 71 degrees 30 minutes W.

9. La Grange quarry. Scattering striae on a planed surface. Bearing S. 58 degrees 30 minutes W.

10. Hawthorne quarry. There are here two sets, each quite heavy scorings. The earlier set follow approximately the line of strike of the dipping layers, bearing S. 64 degrees to 68 degrees W. The later set cross the upturned edges of the layers at a small angle, bearing S. 52 degrees to 54 degrees W.

11. Quarry at crossing of Chicago avenue and Western avenue, Chicago. A few faint striae preserved have a bearing S. 72 degrees W.

12. Excavation for Fullerton avenue conduit in north part of Chicago. Bearing S. 60 degrees W. (recorded in profile of conduit).

13. On Eighteenth and Robey streets, Chicago. The surface of arching layers is *roche moutonneed.* The prominent portions of the surface are striated, the bearing of the striae ranging from S. 52 degrees to S. 57 degrees W.

14. Covel's quarry near Elmhurst, Sec. 17, Tp. 39, R. 12 E. The surface is planed quite extensively and covered with a multitude of striae, bearing S. 63 degrees W.

15. Joliet, bearing 20 degrees north of west. An exposure of striae with this remarkable bearing was found on ledges in the Des Plaines valley, a short distance southeast of the State Penitentiary. The ledges stand 10 to 20 feet above the valley bottom and several striated surfaces were found, with small grooves, as well as fine striae.

16. Du Page bluff, near C., R. I. & P. Railway bridge, east of Minooka. Prof. J. A. Udden reports an observation of heavy glaciation, with grooves bearing about southwest.

17. Near Wilton, quarries are opened, which expose surfaces heavily glaciated with grooves bearing about S. 40 degrees W.

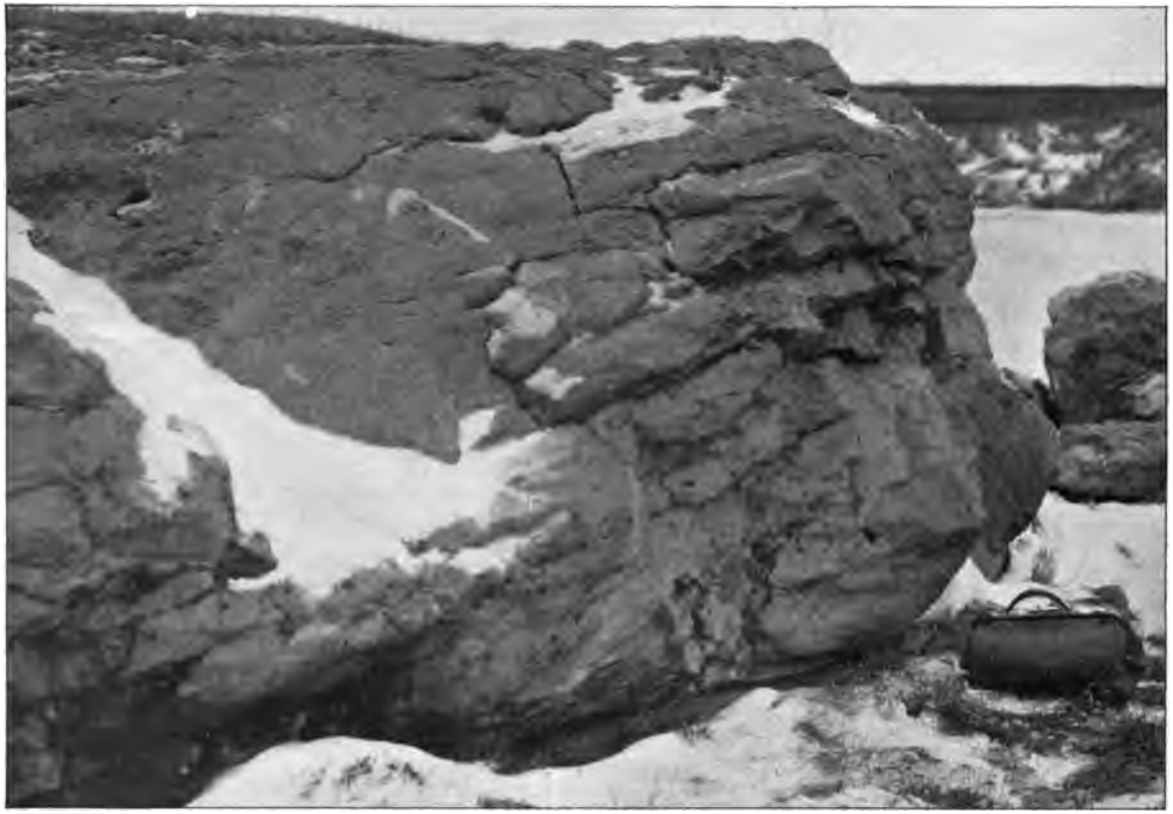

Fig 4. Near view of preceding. The striation on the under surface may be seen near the point where the hand satchel stands. [Photograph by Gayton A. Douglass, March, 1897.

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THE CHICAGO OUTLET AND BEACHES OF LAKE CHICAGO.

PREVIOUS WRITERS. — [illegible]

It is perhaps impossible to determine who was the first person to recognize the evidence or form the conception of a southwestward outlet from Lake Michigan to the Des Plaines. Inquiry among the old residents of this region shows that many of them recognized the beaches as products of the lake, and they also noted that the lake once discharged into the Des Plaines Valley. Evidently these conceptions were entertained for many years before any notice appeared in scientific publications.

Bannister.— Probably the earliest scientific account of the outlet is that given by Dr. H. M. Bannister in the Geology of Cook County, published in 1868, as a part of the Geology of Illinois. However, a report upon the survey of the Illinois River, by Col. James H. Wilson and William Gooding, was published the same year in the report of the U. S. Army Engineers, which makes reference to the former southwestward discharge of Lake Michigan. Dr. Bannister opens his discussion of the old lake outlet and the raised beaches with the following statement:

> "It is evident with a very little observation that at a comparatively recent period, subsequent to the Glacial epoch, a considerable portion of Cook County was under the waters of Lake Michigan, which at that time found an outlet into the Mississippi Valley through the present channel of the Des Plaines."

Dr. Bannister apparently makes no claim to discovery, as is natural, in view of the fact that the outlet had been recognized as such by residents for many years.

Andrews. — One of the early publications of this Academy presents a discussion of the beaches prepared by Dr. Edmund Andrews, a publication which has attracted wide notice (1.) This paper, however, deals mainly with the work of the lake at its present stage. The ancient beaches are briefly discussed, but the outlet is not described. A map accompanying the paper shows the extent of the old lake beyond its present limit from the southern end northward some distance into Wisconsin and Michigan.

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[1] The North American Lakes Considered as Chronometers of Postglacial Time, by Dr. Edmund Andrews, Trans. of Chicago Academy of Sciences. Vol II. 1870. Article 1, pp. 1-24.

Chamberlin. -- Prof. T. C. Chamberlin has presented a brief discussion of the beaches along the Wisconsin shore of Lake Michigan in the Geology of Wisconsin (1), which includes many important data concerning the shore phenomena and an interpretation of the lake history. In the twenty years which have elapsed since this report was published, the studies of the shores of the Great Lakes have brought out a more complex history than had been anticipated, hence the interpretation does not fully meet the case, though it recognizes important fluctuations of lake level.

Leverett. — Although there have been frequent references to the southwestward outlet and the ancient beaches, in geological literature, within the past 20 years, no publication especially devoted to them appeared until 1888, when a paper was published by the present writer in the Transactions of the Wisconsin Academy of Sciences, entitled "Raised Beaches at the Head of Lake Michigan" (2). This paper gives a somewhat detailed account of each of the several beaches found south of latitude 42 degrees 30 minutes, the latitude of the line of Wisconsin and Illinois. It contains but a brief reference to the outlet.

Cooley.—Prof. L. E. Cooley, consulting engineer of the Chicago Drainage Commission, has published two papers which deal to some extent with the Chicago outlet (3). The first paper discusses the outlet as a means for improving the sanitary conditions at Chicago. The second paper deals with it as an important line for navigation and discusses the proper means for obtaining the best results. This paper contains a large amount of valuable data concerning the regimen of the Illinois and Des Plaines Rivers.

Marshall. —The Report of the U. S. Army Engineers for 1890 contains much material collected by Capt. W. L. Marshall concerning the Chicago outlet as a channel for navigation; also references to earlier work by that organization.

Taylor.— Mr. F. B. Taylor has published, in the American Geologist, observations on high beaches in the northern portion of the basin of Lake Michigan. These beaches he thinks pass beneath the present lake level before reaching the southern end of the basin (4). This being the case they have no connection with the outlet under discussion.

(1) Geology of Wisconsin. Vol. 2, 1877, pp. 219-233.

(2) Trans. Wis. Acad. of Sciences. Vol. VII, 1883-87, pp. 177-192. Published in 1888

(3) Water Supplies of Illinois in relation to Health. Report of State Board of Health, 1889.
Lake and Gulf Waterway. Private publication, 1890.

(4) American Geologist. Vol. XIII, May, 1894.

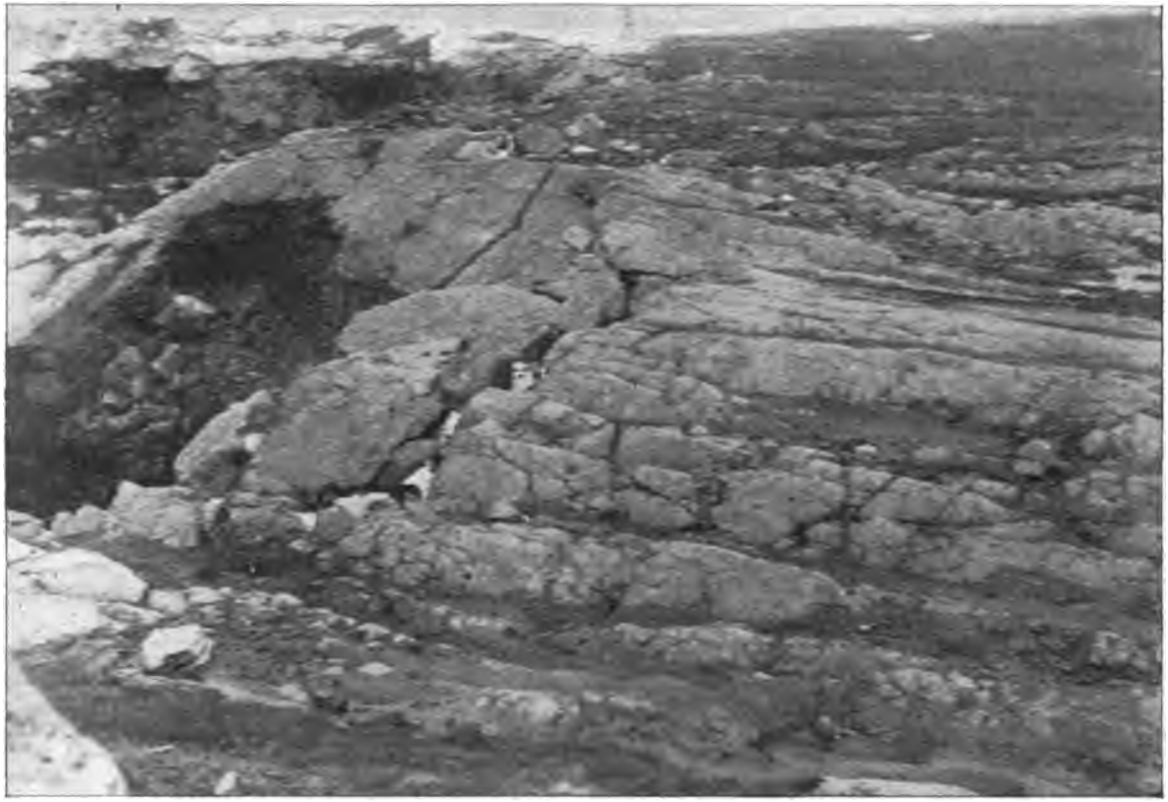

Fig. 5. View of a glaciated surface on "Stony Island," near the preceding, and at about the level of the base of the outcrop. The view looks directly across the line of ice movement. The large trough like channels are depressions between the successive layers of an inclined series of beds, and are only partly produced by glaciation. [Photograph by Gayton A. Douglass, March, 1897.]

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Davis.—Professor W. M. Davis has published a description of the Chicago outlet in the Popular Science Monthly (2). His paper was based upon a personal inspection of the channel with the topographic maps in hand, and is a remarkably clear discussion of the features.

Guthrie. —Mr. Ossian Guthrie, of Chicago, has contributed several newspaper articles and has published two or more pamphlets within the past few years which contain popular accounts of local features in the region under discussion and which have served to stimulate interest in its geological history. Having been a resident of the city for about 50 years and an enthusiastic student of natural features he is in possession of a fund of information which it is to be hoped will be placed on record in suitable form for reference.

THE CHICAGO OUTLET.

The name "Chicago Outlet" has come into use by geologists and engineers without announcement or conference among writers, to designate the line of southwestward discharge from the basin of Lake Michigan across the low divides near Chicago and thence down the Des Plaines and Illinois to the Mississippi. It may appropriately embrace both the points of discharge from the lake to the Des Plaines, namely, the one entering at Summit and the one at Sag Bridge.

When the lake was occupying the highest beach the north or main outlet was entered about three miles southwest of Summit; when occupying the second beach the outlet was entered at Summit; when occupying the third beach the point of entrance appears to have been transferred eastward nearly to the present shore of Lake Michigan, as explained below. Similarly the southern outlet was lengthened eastward with the lowering of the lake. The point of entrance at the time of the highest beach being about five miles east of Sag Bridge, at the time of the second beach near Blue Island, and at the time of the third beach at Riverdale. This relationship of the several beaches to the outlets and the eastward lengthening of the outlets may be readily understood by a glance at the accompanying map. (Plate 3.)

There have been several surveys which have contributed contour maps of portions of the Chicago outlet and the plain covered by the lake in the vicinity of Chicago. The Chicago Drainage Commission have prepared an excellent map with five-foot contours

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[2] The Ancient Outlet of Michigan, by Prof. W. M. Davis. Popular Science Monthly, December, 1894, pp. 218-229.

which covers nearly all of Cook County and the immediate borders of the Chicago outlet along the Des Plaines River. This map has not been published, being merely a study map. The topographic work carried on by the U. S. Geological Survey in this region is largely published. The peculiar features of the upper portion of the outlet are brought out in an effective manner by the following sheets, viz: The Chicago, Riverside, Calumet, Des Plaines, Joliet, Wilmington, Morris, Ottawa, Marseilles, La Salle, Hennepin and Lacon sheets. These sheets cover something over 100 miles of the former lake outlet or nearly one-third the distance from the head of the outlet to the Mississippi. The remainder of the outlet is shown in Professor Rolfe's map sheets, yet unpublished. The reduced contour map (Plate 2) accompanying this paper is based upon these several surveys. It serves to indicate the comparative size of the valleys occupied by the outlet and of the main tributaries of the Illinois. But to fully appreciate the features produced by the outlet, reference should be made to the large scale maps just mentioned.

In the interpretation of these features from the maps, care must be exercised in determining the condition of the valley at the time the outlet first became operative. The portion of the Illinois below Hennepin, it will be observed, is a preglacial valley, which is only partially filled by the glacial deposits. This filling is preserved in terraces along the borders of the valley. The glacial terraces seldom rise to a height of more than 100 feet, and in the lower 100 miles their average height scarcely exceeds 50 feet above the present stream. In the portion of the valley above Hennepin the stream is mainly in a glacial or postglacial course, or the two combined, but even here there are complications which make it no easy matter to determine the amount of erosion attributable to the outlet. Before the accession of the lake waters this valley was the line of discharge for streams issuing from the ice sheet, as possibly of interglacial streams, some evidence of which has been gathered by Professor Chamberlin. Although the streams were generally so heavily charged with detritus as to build up rather than erode their beds for some distance below the point of emergence from the ice sheet, it seems scarcely probable that filling would have exceeded erosion throughout the entire length of the Des Plaines and Illinois Valleys. The basin at the head of the Illinois, as noted above, was apparently occupied by a lake at the Valparaiso stage of glaciation and this would have received the greater part of the detritus borne down by the glacial floods on the Des

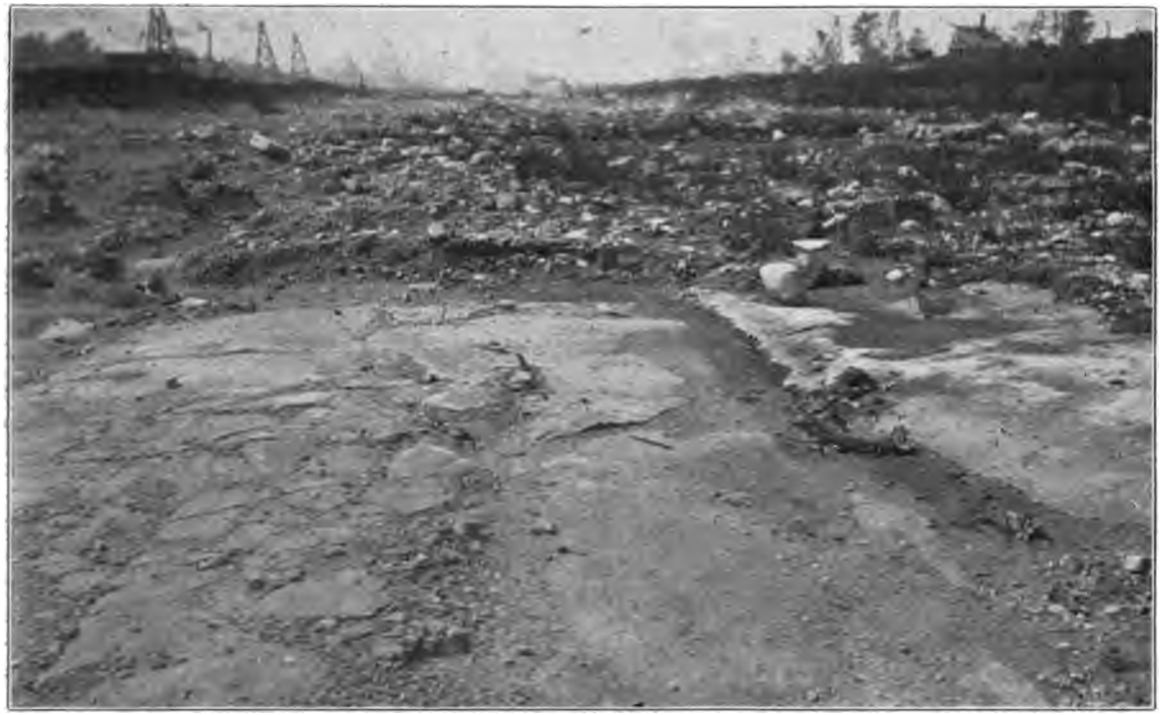

Fig. 6. Striated ledge in bottom of Chicago Drainage Canal near Willow Springs. [Photograph by Chicago Drainage Commission.]

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Plaines and other tributaries entering the basin farther east, thus permitting the water to issue at the western end of the basin, unburdened with glacial material. The stream discharging westward from this basin would therefore have a tendency to deepen the new valley opened across the Marseilles moraine, and in all probability would have extended its excavation at least through the new portion of the valley to Hennepin, there being in that section a gradient of several inches per mile and possibly at first a gradient of several feet. It seems not improbable, also, that some excavation was accomplished by the glacial floods in their passage over the terraces in the lower portion of the Illinois Valley, the advantages for erosion being as good for these floods as for the later ones fed by Lake Chicago.

It is also necessary to estimate the amount of filling which the lower course of the outlet has received since the lake waters were withdrawn. Concerning this filling, Prof. L. E. Cooley has made some investigation and concludes that it will average about 30 feet from Peru to the mouth of the Illinois. (1.)

In the Des Plaines Valley the erosion of the Valparaiso moraine and of the terraces outside of it was probably very largely effected by the lake waters. An examination of this portion of the outlet will therefore be likely to afford a fair understanding of the size of the channel which it formed.

Turning to the topographic maps, it appears that the bed of the lake outlet declines from about 590 feet A. T. at Lemont, in the midst of the Valparaiso moraine, to scarcely 500 feet at the head of the Illinois, or 90 feet in a distance of 25 miles. Of this fall 76 feet is made in a little less than ten miles from Romeo to Joliet pool. The glacial terraces which border the outlet decline from about 630 feet to 570 feet between Lemont and the head of the Illinois. This deepening of the channel is shown by the maps to be somewhat irregular, ranging from 40 feet to about 70 feet, but an average erosion of 50 feet may be assumed. This deepening embraces not only the work at the time the upper beach was forming, but also that carried on during the formation of the middle and third beaches, or down to the time of the final abandonment of the lake outlet. The channel above Joliet has a breadth of one to one and a half miles, averaging perhaps one and a quarter miles. Between Joliet and the head of the Illinois several island-like remnants of the glacial terraces remain in the midst of the channel, making it more difficult to estimate the breadth, but it is

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[1] Communicated to the writer,

not markedly greater than in the portion above Joliet. The portion above Joliet is cut to a slight depth into the Niagara limestone, which there underlies the glacial gravel. The excavation in limestone, however, amounts to not more than one-fourth the size of the channel, for the limestone seldom rises more than 40 feet above the bed of the lake outlet and in many places its surface comes down nearly to the level of the valley floor. Below Joliet there was even less excavation in the rock than above. It is estimated that the rock excavation here does not exceed ten per cent. of the total cutting.

In the low tract at the head of the Illinois (the Morris basin) the depth of excavation by the outlet is very slight, averaging probably less than 20 feet in the ten miles between the head of the Illinois and Morris. The plain appears to have descended nearly to the 520-foot contour on the borders of the river before modified at all by lake or stream action. A low bluff formed on the north border of the basin has a height of 15 to 20 feet. On the south border there is no bluff, that side of the basin being heavily coated with sand deposits. These deposits may perhaps have been laid down in part at the time the lake waters were forming the outlet, but they are probably largely of earlier date. In this basin the lake outlet had an average width of four or five miles.

In the section of the Illinois, immediately below (west from this basin, erosion, prior to the opening of the Chicago outlet, may have brought the level of the valley bottom down to that of the upper beach line of the basin, 550 to 560 feet above tide. The bed of the Chicago outlet is nearly 500 feet, thus leaving about 60 feet depth of erosion. Passing westward the broad bed of the Chicago outlet declines nearly 60 feet in the forty miles between the west border of the basin, just mentioned, and the bend of the Illinois near Hennepin. Whether the valley had the same gradient at the time the accession of lake waters occurred is not known, but it could not have been greatly different, for the glacial terrace just above Hennepin stands about 30 feet lower than the beach lines of the Morris basin, and this terrace was, in all probability, eroded the remaining 30 to 40 feet necessary to give a similar gradient.

The width of the outlet between Morris and Hennepin averages about 1½ miles. The excavation is largely in a soft sandstone, there being nearly continuous rock bluffs to a height of 60 to 75 feet above the level of the bed of the outlet. This sandstone presents much less resistance to stream action than the firm

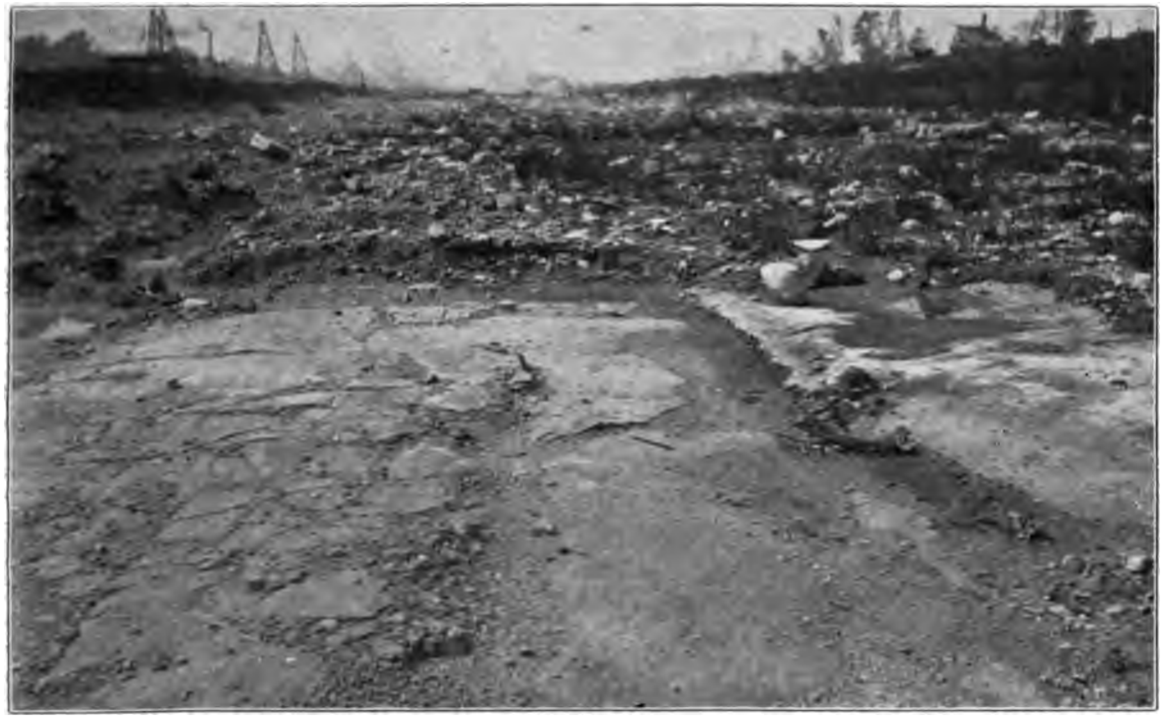

Fig. 6. Striated ledge in bottom of Chicago Drainage Canal near Willow Springs. [Photograph by Chicago Drainage Commission.]

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Niagara limestone. Its resistance, therefore, may not be markedly greater than that of the beds of glacial drift.

As noted above, the level at which excavation by lake waters began in the section below the great bend of the Illinois, is less than 100 feet above the present stream, since the glacial terraces in which the lake outlet was excavated seldom reach a level 100 feet above the bed of the outlet, while below the mouth of the Sangamon they rise scarcely 50 feet above that level. If the 30 feet of filling estimated by Prof. Cooley be added it seems a liberal estimate to allow 75 feet of average excavation in this lower section of 200 miles. It may not have been more than two-thirds that amount. The width of the outlet in this lower section ranges from two up to about five miles, with an average of perhaps three miles. This excavation is in a loose, easily eroded bed of sand and fine gravel, which had been deposited largely by glacial streams.

Summing up the above estimates, it appears that the outlet has a width ranging from one mile up to about five miles, and a depth ranging from 20 feet up to 70 feet. Its length from Summit to the mouth of the Illinois is 300 miles. The excavation is probably not less than three cubic miles. With the exception of about fifteen miles between Lemont and Joliet and forty miles between Morris and Peru, where rock strata have been eroded, the excavation is almost entirely in beds of drift. The width varies with the resistance to erosion, being least in the section where the Niagara limestone was eroded and greatest where there were only drift beds to remove, while in the sandstone the channel is of intermediate breadth. The breadth is also to some degree dependent upon the slope of the bed, being narrower in the portions, with rapid fall, than in portions having a low rate of descent.

Throughout the entire length of the outlet the bluffs are steep, like a river bank, and deposits made by side streams on the edge of the valley are very meager, a feature which indicates that the stream had great volume, probably filling the channel from bluff to bluff, and a current sufficiently strong to carry away nearly all the detritus brought into it by the side streams.

The rapids between Romeo and Joliet occur in a section where the limestone is friable, and it is thought by Professor Cooley that the friability is such that falls could not have been maintained, or even established. The removal of this, the main barrier in the course of the outlet, it is estimated, would require the excavation of a channel in rock only about 20 miles in length and 25 to 75 feet in depth. Of this excavation scarcely one-tenth part was accomnot markedly greater than in the portion above Joliet. The portion above Joliet is cut to a slight depth into the Niagara limestone, which there underlies the glacial gravel. The excavation in limestone, however, amounts to not more than one-fourth the size of the channel, for the limestone seldom rises more than 40 feet above the bed of the lake outlet and in many places its surface comes down nearly to the level of the valley floor. Below Joliet there was even less excavation in the rock than above. It is estimated that the rock excavation here does not exceed ten per cent. of the total cutting.

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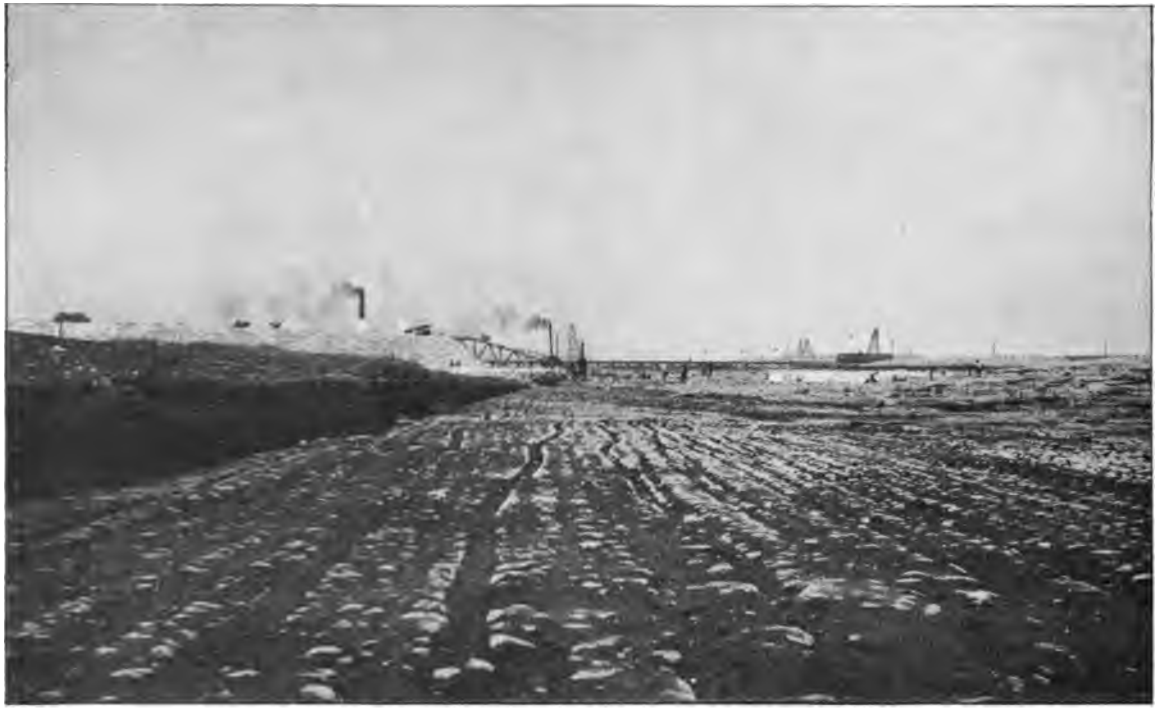

Fig. 7. Channels in bed of Chicago outlet, near Lemont, apparently due to water abrasion rather than ice. [Photograph by Chicago Drainage Commission.]

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Turning to Niagara River, where the work accomplished in a few thousand years by a clear stream is open to investigation, it is found that the recession of the Horseshoe Fall is due almost wholly to undermining, and that the American Fall, in which there is little undermining, is nearly stationary. The cutting on the rapids above the Falls is also very slow and amounts to but a few feet in average depth.

Professor Cooley has called my attention to the deposits at the head of Lake St. Clair as likely to furnish an index of the amount of sediment transported by the Chicago outlet. A delta, with an area of several square miles, has been built in the head of Lake St. Clair, which must have derived the bulk of its material from southward moving littoral currents along both the borders of Lake Huron. In the lake under discussion littoral currents along the west border would have transported material probably in as great volume as on either shore of Lake Huron, but those on the east and south may have contributed less, for wind drifting there is very effective. It seems legitimate to assume that at least half as much sediment was being transported down the Chicago outlet as is carried by the St. Clair River. The waters of the Chicago outlet would be probably more turbid than the Niagara and less turbid than the St. Clair. Prof. Cooley thinks the contributions of sediment to the outlet through the Des Plaines were of little consequence, for this river has, since the lake waters were withdrawn, made scarcely any filling of the outlet below Riverside, where its delta would naturally accumulate. The accession of larger tributaries below may have rendered the stream slightly more turbid than on the rapids, and the rate of rock excavation would have been correspondingly accelerated.

It should not be inferred that this outlet is entirely free from river debris. Beginning at the upper beach, near Summit, there is for several miles a mass of coarse material, largely limestone blocks, too large to have been transported by the current, covering the bed of the outlet. The Drainage Canal exposes excellent sections of the coarse river debris from Summit to Lemont, there being only limited areas in this interval, where the solid rock comes to the surface. (See Figs. 1 and 2.) Below Lemont the bare rock forms much of the floor as far as Joliet. From Joliet to the head of the Illinois perhaps half the floor is covered with deposits of drift and river debris, so that the distance to rock is not known. The remainder is either bare rock or rock with a very thin deposit of coarse river debris, with a liberal supply of bowlders of Canadian derivation. In the Morris basin the rock is largely shale. This has been eroded in places by the current and the hollows filled with sand and gravel. From the Morris basin to the bend of the Illinois the rock floor, mainly sandstone, is generally swept clean. The St. Peter sandstone of this section is of such a texture as to break up rapidly into its constituent grains and these, as fast as they were set free, would have been carried by the strong current down to the lower Illinois, and probably on into the Mississippi. The Lower Illinois has only sand and silt in its bottoms. This section is now in process of silting up, the current being too sluggish to carry away the material brought in from the upper portion of the stream.

In connection with the river debris should be mentioned accumulations of bowlders. The most conspicuous accumulation noted is that on the borders of the Sag outlet, just east of the point where it enters the moraine and northeast of the village of Worth. An area of perhaps a square mile is so thickly strewn that one might almost step from stone to stone over its entire extent. There are, it is estimated, more than 1,000 bowlders per acre. Surface bowlders are not rare in other portions of the old lake bottom, where sand deposits are thin or wanting, there being, perhaps, 100 per square mile on the part of the lake bottom, where till is exposed. There seems, however, to be a tendency to aggregation at the entrance to the old outlets. This feature suggests that floating ice has been influential in their distribution, though there may have been a large number brought by the ice sheet, the head of the outlets being near the inner border of the Valparaiso moraine.

Some very large bowlders have been found along the Drainage Canal, two of which are shown in the accompanying view (Fig. 1). The large ones occur in most abundance where the Valparaiso moraine crosses the outlet. Bowlders are very numerous for a few miles above the junction of the Des Plaines with the Kankakee, both in the lake outlet and the districts south. The cause for their abundance there is not satisfactorily determined. They seldom reach the large size which bowlders in the Valparaiso moraine present.

THE GLACIAL LAKE CHICAGO.

During the past ten or twelve years evidence has been gradually accumulating which points to the existence of several glacial lakes held on the north by the ice sheet and having southward discharge over the lowest points in the rims of the basins which they occupied. The area of these lakes would naturally be variable, since a part of the boundary was formed by an oscillating ice sheet. The outlets of the lakes would also be liable to change on account of the covering of certain low outlets in the early stages which were open to discharge in later stages. A change in the extent and the outlets of the lakes, it appears, has also been produced by a warping of the crust or differential uplift in the region they occupy. The complications are therefore great, and as yet the full history is not worked out. Enough is known, however, to make certain that the general direction of retreat of the ice sheet was northeastward. The southern and western portions of the Great Lake basins were, therefore, the first to become free from ice and occupied by glacial lakes.

While the ice sheet was covering the present outlets of Lakes Superior and Michigan, these lakes had no connection with each other, nor with the lakes to the east, and their discharge was southward or southwestward into the Mississippi, from the present heads of these lakes. A small district west of Lake Erie was also occupied by a lake that discharged southwestward to the Wabash. Upon the withdrawal of the ice sheet from the southern peninsula of Michigan and the southern portion of the Lake Huron basin, the lake at the western end of Lake Erie became expanded and a line of discharge was opened eventually from Saginaw Bay across the southern peninsula of Michigan to the Lake Michigan basin, and this being lower than the outlet to the Wabash, that outlet was abandoned. The waters of the Lake Huron basin being held at a somewhat higher level than those of the Lake Michigan basin, the flow of water was from the former to the latter. The glacial lake, which discharged across the southern peninsula of Michigan extended over the district between Lake Huron and Lake Erie, as well as the Lake Erie basin and the low district bordering it on the south and west. It apparently did not extend far into the Ontario basin, as a study of moraines indicates that the ice sheet occupied that basin at the time of this discharge. It thus appears that the Chicago outlet at one time was the line of discharge for an area much larger than the present Lake Michigan basin.

When the ice sheet withdrew from the Ontario basin an eastward outlet was opened by the Mohawk. The Erie and Huron basins were then made tributary to the Mohawk and Hudson, and it is probable that they never afterwards discharged into the Lake Michigan basin. There are, however, complications not yet fully understood, arising in large part from the differential uplifts of the region, which may have resulted in a brief flow of the waters westward along the straits of Mackinac after the ice had withdrawn from the northern end of the Lake Michigan basin.

The working out of the lake history has also brought evidence that the Lake Michigan basin was for a time free from water in its southern end far within the limits of the present shore of the lake. This low stage of the southern end of the basin, it appears, was due not so much to the shrinking of the lake as to lower elevation in the northern latitudes, for at that time the lake apparently stood above its present level at the north end of the basin. The evidence now at hand points to a general northeastward elevatory movement, following more or less closely the retreat of the ice sheet. While, therefore, the retreat of the ice sheet opened low outlets toward the east and thus led to the withdrawal of the water from the southern and western end of the lake basins, the succeeding uplift at the northeast, complicated by conditions which cannot well be entered into here, raised these outlets sufficiently to cause the water to be thrown back and give these lakes their present extent.

The introduction of the name Lake Chicago, for the glacial lake, which was held in the southern end of the Lake Michigan basin, seems convenient, if not necessary, inasmuch as its area was not coincident with that of Lake Michigan, and its outlet was in the reverse direction. It is also in keeping with the custom of students of glacial lakes, who find it advantageous to have a special name for each of the temporary bodies of water in the several basins. The name, Lake Chicago, seems especially pertinent, since the glacial lake extended about as far beyond the present limits of Lake Michigan, in the vicinity of Chicago, as at any part of its border. It is also a name which readily suggests the position of the lake, and it is in keeping with the name which has come into use for the outlet, namely, the Chicago outlet.

The name Lake Chicago is applied provisionally to all the stages at which there was a southwestward outlet, but it is not yet certain whether they were all formed during the occupancy of a portion of the Lake Michigan basin by the ice sheet. This question is discussed at some length further on.

The study of the beaches of this glacial lake is not sufficiently complete for me to indicate its precise relations to, or points of connection with, the ice sheet. My study has been carried no farther north than to the line of Illinois and Wisconsin on the west side and to a corresponding latitude on the east side of the lake. Prof. Chamberlin's studies left the precise extent of the higher beaches undetermined. Mr. Taylor's observations have been confined to the northern portion of the basin, and as yet no one has examined the intervening district, with a view to determining the limits of this glacial lake. Probably the most favorable field for investigation will be found on the Wisconsin side, since the extensive deposits of wind-drifted sand on the border of the lake in Michigan make it difficult to determine the extent of water action. The long stretches of high bluff, however, interrupt the beaches so greatly that some difficulty is anticipated in making precise correlations on the Wisconsin side.

The Upper or Glenwood Beach.—This beach receives its name from the village of Glenwood, on the Chicago and Eastern Illinois Railroad, a few miles south of the limits of Chicago. The name has been selected (1) because the beach is especially well developed at that village and (2) because, being near the State line of Indiana and Illinois, the name will be familiar to residents of either State.

In the Illinois portion of Lake Chicago this beach is present, except for a few miles between Waukegan and Winnetka, where the lake shore is now farther west than it was at the time this beach was formed. In Indiana the beach is present throughout the entire extent of the border of Lake Chicago in that State, being nowhere less than two and in places twelve miles back from the shore. In Michigan it is absent for a short distance at the "clay banks," north of New Buffalo, where the present shore stands farther east than the shore of Lake Chicago. It is also absent for the same reason for a few miles near the line of Berrien and Van Buren Counties, north of St. Joseph, Michigan. Tracing in detail the course of this beach is as follows:

From the Wisconsin line southward to South Waukegan, it stands only one to two miles back from the shore of Lake Michigan, and comes out to that shore at the point where the bluff of till sets in south of Waukegan. This bluff of till stands above the lake level as far south as Winnetka. From Winnetka a cut terrace, nearly 20 feet in height, extends south along the face of the east till ridge, noted above, to its ter-

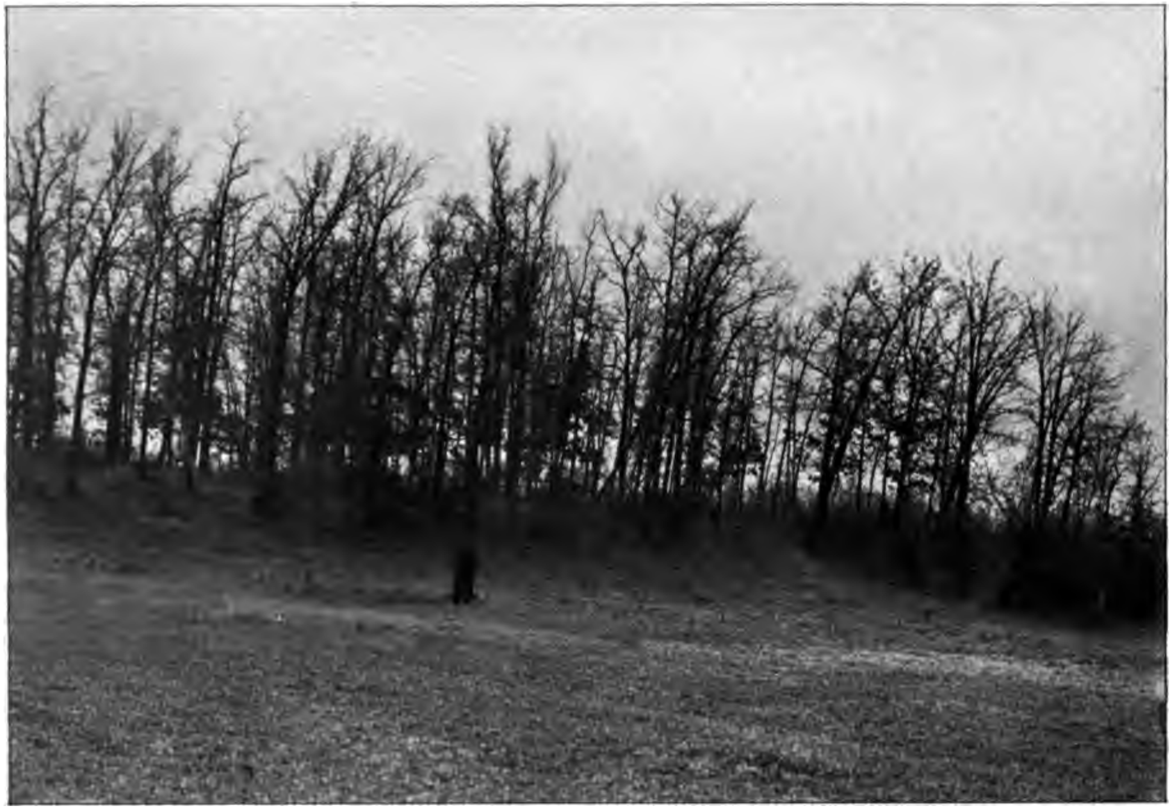

Fig. 8. Cut terrace formed at upper lake level near Galewood. [Photograph by Gayton A. Douglass.]

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minus, perhaps one mile from the point where the terrace departs from the present shore of the lake. From the terminus of this ridge a bar was built out southwestward five or six miles, terminating about a mile east of Chicago River, in the western part of T. 41, R. 13, E. The bar sends out two prominent spurs to the west, a distance of nearly one mile. These probably mark the termini in its earlier stages. The average width of this bar is about one-fourth mile, and it was built up to a height of 10 to 20 feet above the bay back of it. It consists largely of gravel, but has a liberal admixture of sand. The bay back of this bar extended to the valley of the Chicago River and had a width of two to three miles. The northern end finds a narrow extension northward, in Skokie marsh. The site of this old bay is now largely under cultivation, though some portions are still marshy.

The question naturally arises whether this accumulation of gravel and sand was formed by the lake currents and waves, independent of the Chicago River, or was largely formed as a delta from that stream. This deposit is not in the form of a delta built up at the debouchure of the river into the lake, but lies some distance to the east of the river valley. Moreover, to make it still more evident that it was the lake and not the river which contributed the great bulk of the beach deposit, it is found that the river valley above the point where it entered the old lake has very little assorted material, such as would accumulate above a delta.

The beach appears on the west side of the Chicago River, Sec. 19, T. 41, R. 13 E., about a mile northwest from the terminus of the bar. From this point southward to Oak Park the shore is usually a cut terrace (see Fig. 8), with a bank ranging from 6 to 25 feet in height, with occasional deposits of beach gravel and sand along its front. At Oak Park there is an extension of gravel down the east side of the Des Plaines River similar to that of the bar east of the Chicago River, noted above. A ridge or bar 20 to 40 rods in width and 10 feet or more in height extends from Oak Park south about two miles to the south part of Secs. 13 and 14, T. 39, R. 12 E., and there terminates abruptly with a level nearly 20 feet above the plain on its immediate borders.

Passing to the west side of the Des Plaines River, the beach appears about a mile above the southern end of the bar just described and passes in a curving course westward through the south edge of Maywood, in Secs. 14, 22, and 16, T. 39, R. 12 E. This portion of the beach is only two to four feet in height, and at the west it fades out completely.

Its faintness in this district is probably due, in part, at least, to the protection from wave action occasioned by the bar just described. Upon passing south and crossing Salt Creek, about a mile from the point where the beach fades out, it reappears as a well-defined ridge, composed of sand and gravel, rising from 10 to 12 feet above the border of the plain on the east, and having a breadth of 30 to 40 rods. Following this beach southward, it changes in about a mile to a cut terrace, which is well defined from that point southward to the lake outlet, a short distance south of LaGrange. Its course is through the eastern part of the city of LaGrange, where it is in the form of a cut terrace, with bank 10 to 15 feet in height.

Passing to the west side of the outlet, near Willow Springs, the shore line is found as a cut terrace along the east face of the prominent morainic tract which occupies the interval between the two outlets of the lake. Though mainly a cut terrace the moraine is flanked occasionally by deposits of gravel and sand.

South from the southern, or Sag, outlet the shore is carved on the inner face of the Valparaiso moraine with banks 5 to 20 feet, or more, in height, but with only occasional deposits of gravel and sand. Upon approaching the State line, however, near Glenwood, the shore bears away from the moraine and deposits of gravel and sand are built up to a height of 6 to 12 feet or more. These are sometimes in the form of a single ridge, but not infrequently a series of parallel ridges occur, separated by narrow sags.

The effect of the waves at this lake stage is discernible on the borders of Blue Island till ridge, though the western border is characterized by dunes which conceal to some extent the action of the lake.

Upon passing into Indiana the beach soon becomes sandy, like the shore of the present lake, and dunes with an elevation of 10 to 25 feet are formed throughout much of the course in that State. These dunes, in places, have drifted out for a mile or more beyond the old lake border, reaching elevations somewhat higher than the level of the lake. There are occasional points where gravelly deposits have been found in connection with this shore in Indiana and also in Michigan, but the sand, as a rule, conceals the shore products of the lake. One of the best instances noted of a gravelly beach formed at this stage is at Sawyer, Michigan, a few miles south of St. Joseph. The beach is well exposed by a wagon road leading west from the village, about 100 to 120 rods west from the railway station, and at an elevation 55 to 60 feet above the lake.

Near the mouth of the Kalamazoo River, in Michigan, there are extensive sand plains standing 90 to 100 feet above the lake, which seem to have been occupied by lake water. The sand deposits extend back nearly to Allegan, on the Kalamazoo, and southward from the Kalamazoo to Paw Paw River, near Hartford, occupying a strip of lowlands back of a moraine that lies near the lake shore. They may have been formed at an earlier stage than the beach under discussion, in a narrow lake held between the ice and the higher land to the east. It seems probable that a small lake would have appeared during the formation of this moraine. In the present stage of investigation it is scarcely legitimate to assume that Lake Chicago reached so high a level there, a level about 40 feet above that of the beaches at the south and west borders of the lake.

There is very little range of altitude shown in the Illinois portion of this beach, the variations being scarcely more than may be attributed to the fluctuations in the lake or to storms. The following presents the railway elevations in succession, from north to south, at points where this beach is crossed:

Table of Altitudes along the Upper or Glenwood Beach.

STATION.	RAILWAY.	ELEVATION. FEET A. T.
Winnetka,	C. & N. W.	658 640
Oak Glen,	C., M. & St. P.	631
Norwood,	C. & N. W.	640 626
Galewood,	C., M. & St. P.	647 623
Maywood,	C., St. P. & K. C.	636
La Grange,	C. B. & Q.	645 627
Border of Moraine,	C. R. I. & P.	658 630
Homewood,	Ill. Cent.	656
Glenwood,	C. & E. I.	636
Dyer, Ind.	L. N. A. & C.	636

In the above table, where two elevations are given, the lower marks the base of the cut terrace and the upper the brow. It is probable that the lake level was but a few feet above the base. In the Illinois portion it may safely be assumed to be 635 to 640 feet above tide or about 53 to 58 feet above the level of the present lake.

A few gravel pits have been opened in this beach. Probably the most extensive is Haas' pit, near Forest Home Cemetery, one mile south of Oak Park. This is opened in the bar described above as leading southward on the east side of the Des Plaines River. The excavation extends from the east side of the bar west past the center and shows beds dipping at various angles, but all towards the east. Some of the beds increase in thickness as they descend, but the lower bed which is mainly sand decreases in thickness in passing from the higher to the lower part of the bar. It appears to be a sand bar upon which the coarser beach deposits are built. The following section was obtained at the south side of this gravel pit and shows the structure at that particular place only, for Mr. Haas states that the material of the same bed may vary greatly in coarseness within the space of a few feet. The dip of the beds, however, is uniformly toward the east, throughout the entire extent of the pit, which covers an area of several acres:

1. Brown-stained gravel, capping summit and slope......	18 to 30	inches
2. Fine gravel, fresh or stained but little................	24 to 48	"
3. Sand, very thin at top, but increasing toward side of bar	0 to 36	"
4. Fine gravel, increasing like No. 3....................	0 to 48	"
5. Fine gravel, nearly 4 feet in thickness, which passes upward from near the east side of the excavation, assuming a nearly horizontal position beneath the crest of the ridge..	40 to 48	"
6. Sand, thickening toward the higher part of ridge......	0 to 36	"

Mr. Haas reports that shells of the size of unios and also smaller molluscan shells have been found in the bed of sand at the bottom of the pit. The larger shells were thought by him to be unios. A shell, however, which he sent to the writer proved to be the ordinary oyster. This unexpected development raises the question whether this particular shell was in situ at the time it was discovered, if it does not render doubtful the occurrence of any native shells in this bar. Upon visiting the region again and inquiring particularly into the circumstances, there seems little question that the shell was picked up near the base of the pit by some of the workmen, but it was found that there are a few Indian graves on the bar, which extend down nearly to the level of the base of the pit. The shell, therefore, may have been introduced at the time of burial of some brave warrior, or it may have been of more recent introduction. This is apparently the only place along the entire length of the upper beach where molluscan shells have been found, and this negative evidence strengthens the view that the shells at this pit may be intrusions. Remains of terrestrial life have also been found here. Mr. Haas preserved fragments of the tooth of a mammoth found in the gravel pit at a depth of several feet. These fragments are waterworn, and it seems, therefore, quite probable that they were imbedded during the formation of the beach.

Another gravel pit has been opened in the beach between Salt Creek and LaGrange, in which the excavation extends from the east side of the beach westward nearly to the outer slope. It has a depth of 12 to 14 feet in the deepest part, and exposes a series of beds dipping slightly toward the east. The upper five feet is of brown stained gravel. The lower portion is a fine gravel, with very little stain. In the gravel there are sandy pockets and also thin beds of sand. These sandy portions, in some cases, show a slight effervescence with acid, but are not nearly so calcareous as the sand found at similar depths in glacial deposits.

Interval of Emergence. — After the Glenwood beach was formed the lake appears to have withdrawn from the plain between the beach and the shore of Lake Michigan, in Illinois. How much farther north it withdrew is not accurately determined. Professor Chamberlin recognized evidence of emergence between the formation of this beach and the second beach, in Southeastern Wisconsin. That it withdrew so much in the northern end of the Lake Michigan basin as in the southern seems improbable from the evidence drawn from tilting, it being found by Mr. F. B. Taylor that that portion of the basin has been uplifted more than the southern. Whether this emergence is to be connected with the lake stage, known as the Algonquin, is not yet ascertained, though that seems a probable correlation.

The evidence for this emergence within the Chicago area is found in beds of peaty material that occur beneath gravel of the succeeding lake stage, as long since noted by Dr. Andrews and discussed in his paper cited above. In Wisconsin the evidence is in clay beds, which seem to have been left in a retiring water body, and which are covered by beach deposits of the succeeding lake stage, as pointed out by Prof. Chamberlin in his official report of the Wisconsin Geological Survey. There is need for further study of this interval in the lake history before conclusions of much consequence can be drawn.

The Second or Calumet Beach.—This beach throughout much of its course in Indiana and for a short distance in Illinois follows the south border of the Calumet River, and because of this close association the name Calumet seems appropriate. It stands about 20 feet lower than the Upper beach, and its course in the Illinois portion of the region traversed by it is indicated on the accompanying map (Plate 3). From the Wisconsin line southward to Chicago River it is closely associated with the Upper beach, wherever that beach remains. From the Chicago to the Des Plaines River it is separated from the Upper beach by an interval of 1½ to 3 miles. The outlet at this stage was at the Des Plaines River, between the villages of Riverside and Summit, and the beach gravels are well developed for a short distance below Summit on the east side of the outlet. The beach leads somewhat directly southeastward from Summit to the north end of Blue Island ridge and then southward along the east side of the ridge, past Washington Heights to the Calumet River, two or three miles east of Blue Island. The Sag outlet had its head at this time in a wide opening between the Calumet and Thornton. Immediately east of Thornton the beach reappears in its customary strength and passes thence eastward across Lake County, Indiana, following the south border of Calumet River at an average distance of perhaps a mile from this stream. In western Porter County, Indiana, near the line of Portage and Westchester Townships, it crosses to the north side of the river, and its course from that point eastward across Porter and northwestern LaPorte Counties is nearly parallel with the present shore of Lake Michigan and distant from it two to three miles. In Michigan it borders the lake even more closely, as far north as observations were carried (to latitude 42 degrees, 30 minutes), being found usually within a mile or two of the lake shore.

This beach extended a conspicuous bar out some distance into the lake above Chicago. Its northern end is found at the lake shore between Wilmette and Evanston, and leads thence southward through the west part of Evanston to Rose Hill Cemetery, and there turns abruptly westward and terminates at the village of Bowmanville, on the east bluff of Chicago River. It is probable that this bar was attached to the old shore at some point farther north than its present terminus, a portion of it having been removed by the encroachments of Lake Michigan. The bay back of this bar had a width of one to four miles and a depth of 15 to 20 feet in its deepest parts. Portions of it were so shallow as to be marshy. Notwithstanding the presence of this bar the beach back of it seems to have been acted upon by lake waves with nearly as much vigor as the portion of the beach farther south, which was not thus protected. The bar is much stronger than any part of the beach proper, being 10 to 20 feet in height and nearly one-fourth mile in average breadth—if the sand and gravel on its borders are included.

The second beach is, on the whole, characterized by larger deposition than the upper one, there being throughout much of its extent a line of sandy gravel, 5 to 10 rods or more in width and 2 to 5 feet in height, but it has less conspicuous cut terraces. Its strength is greater in the vicinity of the northern outlet and on the north side of the southern outlet than at points between or outside the outlets. In Illinois and Michigan, however, it is heavily covered with sand, which is probably in large part wind drifted. These accumulations of sand in places reach the height of 30 to 40 feet.

Occasional reports of the discovery of a molluscan shell in this beach have come to my notice, but none have been personally noted. In this respect it is similar to the Upper beach, but in striking contrast with the next lower beach, which is full of fossils.

An excellent exposure of the structure of the bar noted above is found immediately north of Evanston, where the lake is undermining the bar as well as subjacent deposits. The beach sands and gravels rest upon a bed of peat, which was noted by Dr. Andrews and interpreted by him to be the accumulation of a marsh or partially summerged land surface. The peat not only underlies the bar under discussion, but extends eastward across the interval between it and the Third beach. Its level is no higher than that of the Third beach, being but 12 to 15 feet above the present level of Lake Michigan. The peat is in places several feet thick, but at the point where the bar comes out to the lake shore it has a thickness of only 3 to 6 inches. It contains pieces of mangled wood and has been disturbed by waves. Between the peat and the yellowish blue till, which forms the base of the exposure, there is a gravelly sand 6 to 18 inches in thickness, which appears to be a lacustrine deposit. The peat is immediately overlain by about 5 feet of sand, above which there is a bed of coarse gravel. The gravel is thin near the borders of the bar, but has a thickness of 11 to 12 feet beneath the highest part. It is capped by a thin deposit of sand and has layers of sand interstratified with it in its thickest part. The presence of this gravel makes it impossible to suppose that the old land surface has been buried by the drifting of material from the lower beach.

There seems no escape from the conclusion that the lake stood at a lower stage than the level of the second beach before that beach and the bar under discussion were formed.

The Third or Tolleston Beach—This beach receives its name from the village of Tolleston, situated in Northwestern Indiana at the crossing of the Pittsburg, Ft. Wayne and Chicago Railway and the Michigan Central Railway, at a point immediately south of the extreme head of Lake Michigan, and distant only 2½ miles from the head of the lake. It is more complex than either of the higher beaches, and it becomes a matter of no small difficulty to determine what beaches should be included with this lake stage. There are, by actual count, 32 beachlets crossed on a N.-S. line about three miles east of the State line of Illinois and Indiana. The outer line of this series is usually much stronger than the others and stands a few feet higher, and hence is considered the main line. The village of Tolleston and also Hessville and Miller Station, in Indiana, are situated on the outermost or main line.

Many of the beachlets situated between the main line and the shore of Lake Michigan stand only 10 to 12 feet above that lake, and, as shown further on, seem to have been formed after the southeastward outlet was abandoned. This being the case they should not be referred to Lake Chicago. The Third or Tolleston beach, as here described, includes only such beaches and bars as have sufficient elevation above the sill of the Chicago outlet to indicate that they are connected with that outlet—beaches whose elevation is 18 to 25 feet above the level of Lake Michigan.

The portion of the shore of this lake stage, in Lake County, Illinois, is closely associated with that of the higher lake stages, and consists of a gravelly deposit flanking the foot of the cut terrace. In Cook County this beach appears on the grounds of the Northwestern University, in Evanston, and for several miles south it lies near the east border of the bar formed at the next preceding lake stage. From Rose Hill Cemetery southward it is beyond the limits of the bar, but is perhaps itself a bar built out southward into a bay now traversed by Chicago River. It appears to have reached some distance south at an early part of this lake stage, for no well-defined beach appears on the west side of the bay back of it. This bar lies within a mile of the present shore of Lake Michigan and is readily traced as far south as Lincoln Park. The bar is said to have been nearly continuous through the city of Chicago, but it is now obliterated from Lincoln Park southward nearly to the Douglas Monument, and I have been unable to obtain a map or other accurate data showing its former extent. The bar is preserved from the Douglas monument southward to Englewood, a distance of four or five miles. This portion consists of a series of overlapping ridges, of which the westernmost or earlier terminate further north than their successors on the east. At the termination of each of these ridges a hook turns out to the west into the bay that was inclosed by the bar. An outlet seems to have been maintained toward the Des Plaines around the southern end of this bar, until it reached Englewood. This may not have been closed until the water level had dropped too low for a discharge to the Des Plaines.

Passing across the outlet marsh from Englewood to South Lynne, a continuation of this beach is found. It leads in a course east of south to South Englewood and thence more easterly across the northwest corner of Calumet Township into Hyde Park, coming to the Illinois Central Railway a short distance north of Pullman. From this point a gravelly ridge is traceable southward past the north border of Lake Calumet, where it dies out in the marsh. A slight beach is formed to the northeast from here on Stony Island, between Lake Calumet and South Chicago. But the main line of this beach is found west of Lake Calumet, running north and south through the west parts of Pullman and Kensington, where it usually has the form of a cut terrace, with banks 10 to 15 feet in height, but changes to a gravelly and sandy beach at the south. This beach comes to the Calumet River at Riverdale, where it connects with the Sag outlet. It reappears on the south side of the river at Dolton and passes thence southeastward into Indiana. Its course in Lake County, Indiana, is eastward through Hessville and Tolleston and Miller. In Porter County it continues with a slight deflection to the north, keeping parallel to the shore of Lake Michigan, and enters LaPorte County near the south edge of Michigan City. A short distance northeast from Michigan City it becomes merged with the dunes of the present shore, and no attempt was made to separate it beyond that city.

The Illinois portion of this beach consists mainly of fine gravel, which is usually well worn, but in places has considerable angular material, as if formed rapidly and subjected for but a brief period to the action of the lake waves. The low district along the Chicago River back of this beach has received quite generally a coating of sand several feet in depth, and the marshy tracts in Hyde Park and Lake Townships are also covered with sand to a depth of several feet. Excavations have shown, however, that till usually sets in at a depth of 10 to 20 feet or less (1).

In Indiana this beach, like the present shore of Lake Michigan, is very sandy. Its dunes, however, seldom reach a greater height than 50 feet, or but one-third to one-quarter the height of dunes on the present shore. Wells along it have occasionally encountered a bed of gravel at the base of the sand at levels, corresponding with the gravelly beaches of the Illinois portion.

One of the best exposures of this beach in the Chicago area is found at the border of the campus of the Northwestern University at Evanston. The following sections, one taken by Dr. Oliver Marcy, of Northwestern University, in 1864, at which time there was a peculiarly good exposure, the other taken by the writer in 1887, at which time there was a less extensive exposure, show a slightly different section. The beach in this interval had suffered an erosion of perhaps 75 or 100 feet.

Section of Beach at Evanston made in 1864.

1.	Surface soil, sandy	1½	feet
2.	Brown sand and fine gravel	2½	"
3.	Coarser gravel, stratified	2½	"
4.	Fine sand	2	"
5.	Gravel, containing bones of deer	1 1-3	"
6.	Fine sand, containing oak logs	1½	"
7.	Peat or carbonaceous earth with a marl bed containing molluscan shells in the lower portion or interstratified with the peat	1½	"
8.	Gravel	3¼	"
9.	Humus soil, with stamps and logs (coniferous)	½	"
10.	Yellow clay, laminated and contorted, containing pockets of gravel	3½	"
11.	Blue, pebbly clay	2	"
	Height of bluff	22	feet

Section of Beach at Evanston in 1887.

		Feet.	Inches.
1	Yellowish-red, iron stained sand	3 to 5	
2	Band of bog iron ore, granular		4 to 6
3.	Gravel, with beds of sand included (the stratification is very irregular in thickness and assorting very imperfect)	5 to 7	

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(1) The writer is indebted to Mr. W. C. Holden of the U. S. Geological Survey for many data concerning the distribution of the sand and for access to the accurate maps of the Pleistocene deposits in Chicago, which he has prepared for the Survey.

4. Coarse sand, not calcareous		6 to 12
5. Calcareous loam		3
6. Yellow clay, very calcareous, with leaves imbedded		3
7. Carbonaceous band, not calcareous		2
8. Yellow calcareous clay, similar to No. 6		4 to 6
9. Band of carbonaceous material, not calcareous		2
10. Brown sand, with twigs and peaty material		8 to 10
11. Water bearing sand and talus-covered slope	8	
Height of bluff	20 to 22 feet.	

The calcareous clays, Nos. 6 and 8, of the last section, and Nos. 6 and 7 of Dr. Marcy's section, contain numerous gasteropod shells. Dr. Marcy has collected a large number of shells from this horizon, among which there are Unios, apparently of several different species, but not specifically identified. Mr. C. T. Simpson has identified nine different genera of mollusks, all of existing species, found in No. 7 of Dr. Marcy's section. Planorbis and Lymnea are very abundant. Prof. D. P. Penhallow has identified two wood specimens, one a new species of Picea (Picea Evanstoni), the other a new oak (Quercus Marcyana) (1). The bone of the deer, found by Dr. Marcy, is a portion of the femur. The writer has found many localities in the sandy portions of this beach, where molluscan shells abound. Nearly every exposure in the sandy district west of the beach, from the main part of the city of Chicago southward to Englewood exhibits them. This beach is, therefore, in striking contrast with the two higher beaches, which contain few remains of aquatic life.

An excellent artificial section across this beach, made by the Fullerton avenue conduit, which leads from the Chicago River eastward to Lake Michigan, across the north part of Chicago, is discussed above. The deposit throughout is mainly sand, but some gravel is encountered. Shells of Unios and other mollusks were noted at frequent intervals throughout nearly the whole width of the deposit. Beneath these beach deposits there is everywhere a pebbly blue-gray clay, apparently an unmodified glacial till. Some of the sewer ditches in Hyde Park, west of Grand boulevard, have reached peat deposits below sand, at a level a few feet above the lake. Wood has often been found in the sand west of this beach in Chicago.

Reference has been made to the beachlets which occupy the interval between the main beach and the present shore of the lake.

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(1) Trans Royal Society of Canada, 1891, pp. 39-32, plate II.

These do not form continuous lines around the head of the lake, but those in the vicinity of the Chicago University and Jackson Park die out in the marsh, which sets in a short distance south of the park, and those in Lake County, Indiana, die out at their western ends in a sandy plain, which borders Wolf Lake, Lake Calumet, and other small lakes near the State line. This sandy plain stands but 5 to 8 feet above the lake and was apparently an open bay at the time these bar-like features were forming. But it has now become filled with sand, leaving Lake Calumet and the other small lakes as its dwarfed representatives. The beachlets stand only 10 to 12 feet above lake level (except where coated by wind-drifted sand) and are, as noted above, to be referred to the action of the present lake rather than to Lake Chicago.

The outlets of the lake at the time the Third beach was forming appear to have been along three lines; one, that occupied by the mouth of the Chicago River and the south branch of the Chicago River (reversed); a second along the marsh referred to above as leading from the south part of Hyde Park Township northwestward between Englewood and South Lynne, which connects with the south fork of the Chicago River north of the Union Stock Yards; a third leading westward from Riverdale along the Sag outlet. The broadest of these outlets is that leading past Englewood and the Union Stock Yards, and it is possible that the other outlets became nearly closed by sand before this outlet was abandoned.

The altitude of this beach is nowhere more than 20 to 22 feet above the lake (except where wind has drifted sand to higher levels). The outlets could not well have been cut below a level 8 feet above the lake, that being the altitude of the Chicago outlet for several miles below its junction with the present Des Plaines River. The depth of the water in the outlets would, therefore, be 10 to 12 feet or less. As beaches are often built up to a height of 4 or 5 feet above the ordinary level of the lake, it seems probable that the ordinary stage of water was not more than 15 feet above the present stage of Lake Michigan, thus leaving but 7 feet depth of water in the outlet. The Sag outlet reaches nearly 15 feet above the level of Lake Michigan, hence it was probably at all times a minor line of discharge.

As hinted above, the reference of this beach to the same lake which formed the higher beaches is not made with any degree of confidence. Indeed, the abundant life of the waters which formed this beach distinguishes it so strikingly from the paucity of life which characterizes the other beaches that a suspicion of a different origin at once arises.

Dr. J. W. Spencer has advanced the view that an uplift at the Niagara outlet is still in progress, and has suggested that the recession of the falls of Niagara past Johnson's Ridge, a ridge standing higher than the remainder of the gorge and situated about a mile north of the Falls, would have caused a temporary partial discharge of the upper lakes, including Lake Erie, into the Mississippi, a discharge which did not stop the outflow by Niagara. He maintains that when Niagara Falls had effected the incision through the Johnson Ridge, the level of Lake Erie fell about 24 feet, reaching a level 17 feet below the Chicago divide, and thus the full flow of the outlet was returned to Niagara. (1.)

The test of the value of Dr. Spencer's ingenious suggestion lies in the occurrence of phenomena immediately south of the ridge, which will demonstrate that the water stood at a level sufficiently high to have caused outflow through the Chicago outlet. Such a stage of water should have left shore markings there as well as on the plain at the head of Lake Michigan. The view that an uplift is still in progress in the vicinity of the Niagara outlet also seems to be sustained by very weak evidence.

Prof. L. E. Cooley has called my attention to rapids at the head of St. Clair River, which he thinks may have a bearing upon the lowering of the lake level a few feet in recent geological times. For several miles the St. Clair River has a fall of about 16 inches per mile, making nearly all the descent of nine feet which is made between Lake Huron and Lake Erie. This rapid portion is stated by Professor Cooley to be cutting glacial drift, and it is his opinion that this drift barrier may have at one time held the lake level even as high as the second beach. The matter is one worthy of investigation, and Professor Cooley has hoped to give it fuller attention. The question of the date of this beach and of its relation to uplifts and barriers must therefore be left open until more substantial evidence is gathered.

THE PRESENT BEACH OF LAKE MICHIGAN.

Dr. Edmund Andrews has discussed the present beach of Lake Michigan in his paper published in an early volume of the Transactions of this Academy, and compared its strength with that of the beaches of Lake Chicago (2). Since this paper is now out of

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(1) Proc. A. A. A. S., Brooklyn Meeting, 1894, pp. 242-243.

(2) Trans. Chicago Academy of Sciences, Vol. II, 1870, pp. 1-23.

print and copies of it are difficult to obtain, the computations made by Dr. Andrews are presented below. Dr. Andrews apparently includes the beachlets referred to above in the present lake stage.

The lake is encroaching upon the district on its west border from the Wisconsin line southward to Chicago, though piers built along the shore in Chicago and for some distance northward now prevent further encroachment. Along the border of Hyde Park, in the south part of Chicago, the lake is building a beach and is tending to fill in rather than to extend the lake in that region. In Indiana the lake is filling in rather than extending its borders. In Southwestern Michigan it is eroding the prominent parts and filling in the bights, thus giving the lake a more regular outline. In this connection it may be remarked that the effect of the lake generally is to remove the prominent parts and fill the bights.

Dr. Andrews computed the bulk of the beach as follows: For 25 miles west from Michigan City it maintains an average cross section of about 6,000 square yards, and its contents are 264,000,000 cubic yards. In this division the beach is in the form of a lofty belt of sand dunes, about one-third of a mile wide, and in places 160 to 200 feet in height. In the next eight miles west this beach spreads out into a broad belt of low parallel ridges, about two miles in extreme width. This division has a cross section of about 16,000 square yards, after deducting the sand which was deposited by Lake Chicago. Its contents amount to 225,280,000 cubic yards. From the Indiana line, near Wolf Lake, to Chicago River, a distance of sixteen miles, the sand occupies a belt estimated to be seven yards thick on the shore and running out to a thin edge at the average distance of 2,500 yards inland. It, therefore, has a cross section of 8,750 square yards and contains 246,400,000 cubic yards. To this should be added the portion of the beach under water. This, taken for the entire distance from Chicago to Michigan City, is estimated to be about 1,011,890,000 cubic yards. The computation of the subaqueous belt is as follows: The sand at the shore line is about 10 feet deep, and it extends out to where the water reaches a depth of 24 to 36 feet. The breadth varies greatly, ranging from about 1,000 yards to nearly five miles, the widest part being at the head of the lake. The total bulk of the lake deposits, both in and out of water, in the section between Michigan City and the mouth of Chicago River, is estimated to be 1,747,570,000 cubic yards.

Dr. Andrews estimates that the combined bulk of the beaches formed by Lake Chicago is nearly equal to that of the beach of the present lake, the proportion being 16 to 17. In this computation it was assumed that 656,000,000 cubic yards escaped through the Chicago outlet. This assumption is based on a comparison of the relative sizes of the beaches of Lake Chicago in a section outside the outlet and a section embracing the outlet.

Dr. Andrews attempted to estimate the length of time involved in the accumulation of the beach deposits by measuring the amount of sand carried southward past the piers at Chicago and Michigan City. The sand annually stopped by the two piers was found to be 129,000 cubic yards. If this represented the whole drift past the piers the period represented in the accumulation of the sand in all the beaches would be 26,000 years, and the duration of Lake Michigan at its present stage 13,000 years. He estimates, however, that not more than one-fourth or one-fifth of the southward drifting sand is stopped by the piers, and thus reduces the period to less than 6,000 years, with but about 3,000 years for Lake Michigan.

Dr. Andrews' estimates were based on the assumption that there is a southward flowing current on each side of the lake, carrying sand to its present head. Investigations made by the Weather Bureau in 1892 and 1893, under the direction of Prof. Mark Harrington (1) led him to the conclusion that the currents on the east shore in the southern portion of the basin are northward instead of southward. He accounts for the accumulation of sand on the north side of breakwaters along this coast by the action of the surf, in northerly storms, which is more transient than the currents proper and would affect the southern part of Lake Michigan only when the wind was northerly. This occasional phenomenon is very efficient when it occurs. He concludes that the estimates of time involved in the formation of beaches have, therefore, less value than would be the case were the accumulations due more largely to lake currents.

Considerable study of the movement of water in Lake Michigan has been made by the Chicago Drainage Commission, largely under the direction of Professor Cooley. As a result of these investigations, which involve not only a study of bottle papers, but also a thorough canvass of the opinions of lake captains and an examination of breakwaters, Mr. Cooley has reached the conclusion that the effective work on the shores is due to waves and not to currents, and it is a matter of doubt if this lake has such a system of currents as are indicated by Professor Harrington's charts. The movement of the water seems to depend mainly upon the wind, but is governed to some degree by the contours of the shores. If the north winds prevail for a few days, as is often the case in the spring months, the surface water appears to have a southward movement throughout the breadth of the lake, and return currents must be at some depth. On the other hand, a prevailing south wind, such as occurs for short periods during the summer, will induce a northward movement across the entire breadth of the lake. The contours of the shore seem to favor a northward movement from direct west winds in the north half and a southward movement in the south half of the lake. As the prevailing winds are from the west these become the most protracted of the movements of surface water. Professor Cooley has found that breakwaters along the shore support this interpretation. In the southern half of the lake they are largely constructed to protect the harbors from the drift on the north side, while in the northern half they are constructed to protect them from drift coming from the south. In view of this apparently changeable course of lake movement, it seems doubtful if estimates, such as Dr. Andrews attempted, have the value that some have attached to them.

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(1) Currents of the Great Lakes as deduced from the movements of Bottle Papers during the seasons of 1892 and 1893, by Mark W. Harrington, Weather Bureau, Bulletin B, U S. Department of Agriculture, 1894.

Dr. Andrews also made an estimate of the age of the lake from the annual amount of destruction of the bluffs. To determine the rate of erosion on the west coast of Lake Michigan he gathered a large number of observations, mostly derived from surveys, and after rejecting loose or vague estimates, as well as erosions brought to notice because of remarkable rapidity, he obtained the results given in the following table:

At Evanston the erosion is	16.05	feet	a year
At the Old Pier, two miles further north	4.00	"	"
One mile further north	3.08	"	"
At Winnetka	4.05	"	"
One mile further north	0.05	"	"
Lake Forest	1.05	"	"
Waukegan	0.00	"	"
Two miles further north	0.00	"	"
State line	16.50	"	"
Kenosha	12.00	"	"
Two miles further north	3.00	"	"
Three miles further north	12.00	"	"

Racine Point	16.00	"	"
Racine	6.00	"	"
Oak Creek	2.00	"	"
One mile further north	1.60	"	"
Milwaukee	6.25	"	"
Port Washington	2.30	"	"
One mile further north	1.50	"	"
Place further north	3.00	"	"
Place four miles south of Sheboygan	8.00	"	"
Sheboygan	6.25	"	"
Manitowoc	5.00	"	"

From the above table it appears that the average erosion in the portion of the shore between Milwaukee and Manitowoc is 4.33 feet per year, while between Milwaukee and Evanston it is 6.24 feet per year. The average erosion of the two sections is 5.28 feet.

A series of more careful measurements than those given in the above table appears in the Geology of Wisconsin and covers part of this section of the shore. The following is the statement furnished by Dr. Lapham to Prof. Chamberlin (1):

"Mr. S. G. Knight, of Racine, has carefully measured for the Geological Survey, from the nearest section corner or quarter post, to the bank of Lake Michigan, along all the section lines in Racine County, the results of which, compared with the Government Survey made in 1836, are given in the following table. Had these measurements been made at right angles to the shore line the result would have been a trifle less; but as some portions of the bank have been artificially protected we may assume the result as a close approximation to the actual amount of loss, during the past thirty-eight years in Racine County. These measurements will have their value many years hence."

LAKE SHORE IN RACINE COUNTY.

Section Lines.	1836. Chains.	1874. Chains.	Loss. Chains.
North line, Sec. 6, T. 4, R. 23	32.70	30.30	2.40
North line, Sec. 7, T. 4, R. 23	34.68	33.45	1.23
West line, Sec. 8, T. 4, R. 23	30.18	29.70	0.48
North line, Sec. 17, T. 4, R. 23	16.38	14.60	1.78
West line, Sec. 16, T. 4, R. 23	10.86	9.75	1.11

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(1) Geology of Wisconsin, Vol. II, 1877, pp. 231-232.

North line, Sec. 21, T. 4, R. 23	15.58	14.50	1.08
West line, Sec. 22, T. 4, R. 23	19.39	18.43	0.96
North line, Sec. 27, T. 4, R. 23	26.39	26.39	0.00
North line, Sec. 34, T. 4, R. 23	16.04	15.47	0.57
West line, Sec. 34, T. 4, R. 23	31.50	30.00	1.50
North line, Sec. 4, T. 3, R. 23	28.03	26.50	1.53
North line, Sec. 9, T. 3, R. 23	18.82	18.00	0.82
North line, Sec. 16, T. 3, R. 23	27.80	20.60	6.20
North line, Sec. 21, T. 3, R. 23	21.25	18.00	3.25
North line, Sec. 28, T. 3, R. 23	32.22	31.16	1.66
West line, Sec. 28, T. 3, R. 23	30.20	23.87	6.33
North line, Sec. 32, T. 3, R. 23	34.85	32.40	2.45
South line, Sec. 32, T. 3, R. 23	46.60	44.73	1.87

Mean of eighteen places, chains................................ 1.92

Same in feet, 126.72.

Loss per annum in feet, 3.33.

"The following measurements were made to ascertain the amount of the abrasion of the west shore of Lake Michigan, in Milwaukee County, since the Government Survey, made in 1835 and 1836:

Place.	1835. Chains.	1874. Chains.	Annual Loss. Feet.
South line, Sec. 1, T. 5, R. 22	45.61	44.50	1.9
South line, Sec. 36, T. 6, R. 22	15.90	14.40	2.6
South line, Sec. 24, T. 6, R. 22	19.20	18.70	1.0
South line, Sec. 21, T. 7, R. 22	8.72	8.42	0.5
South line, Sec. 15, T. 7, R. 22	5.37	2.82	4.3
South line, Sec. 10, T. 7, R. 22	43.35	41.04	2.0
South line, Sec. 3, T. 7, R. 22	19.34	17.36	3.33
South line, Sec. 34, T. 8, R. 22	22.00	18.00	5.61

Mean 2.77

"The loss in the other counties bordering the lake is less on the average."

In view of these measurements reported by the Wisconsin Survey, the rate for the entire shore is probably scarcely more than half that of Dr. Andrews' estimates.

Dr. Andrews calls attention to the existence of a submerged terrace, which, he thinks, furnishes a ready means for determining approximately the original position of the shore, and consequently the distance which the bluffs have receded since the water occupied its present level. Where the shores are of drift clay the terrace generally has a breadth of from 2 to 6 miles, but at the south end of Lake Michigan it is nearly ten miles. The west shore of Lake Michigan was examined in some detail between Chicago and Manitowoc and found to have an average width of 3.98 miles. This terrace slopes gently outward to the depth of about 60 feet, when the bottom dips more suddenly to the deep water of the basin. It is thought by Dr. Andrews to be the product of wave action and is denominated by him the terrace of erosion. The present writer, however, has no opinion concerning its origin. The time required for the formation of this terrace was computed by using the average width of the terrace as a dividend and the annual rate of erosion as a divisor. As the outer edge of the terrace is at the depth of 60 feet, the position of the old shore was assumed to be at a point where a line drawn from the top of the present bluff of the lake to the outer edge of the terrace would meet the surface of the lake. These estimates give the average position of the old shore, a distance of 2.72 miles from the present shore. Dividing this distance by the annual rate makes the total age of the terrace 2,720 years, or a duration nearly the same as that computed by the drifting of the sand. If the rate of erosion determined by the Wisconsin Survey be substituted the age would be 4,708 years.

The estimate based upon the rate of erosion of the shore of the lake is probably much more reliable than that based upon the drifting of the sand past the piers, but the great variability in the height of the shore (from 10 feet up to 100 feet or more) and the variability in the rate of recession (from 0 to 16.95 feet per year) make it evident that the above computation is at best only a rude approximation. These estimates serve, however, as a provisional measurement of the duration of this stage of the lake and have much value in its bearing upon the length of postglacial time. Dr. Andrews remarks that they are useful, in showing that it is impossible to allow, even on the most liberal estimates, any such postglacial antiquity as 100,000 years, which has often been claimed.

ACKNOWLEDGEMENTS.

In the preparation of this paper and its illustrations, I am happy to acknowledge the aid kindly given by many persons, among whom should be mentioned Prof. Oliver Marcy, Prof. L. E. Cooley, Prof. W. K. Higley, and, most of all, Prof. T. C. Chamberlin, the President of this Academy. In the preparation of

photographs, I am indebted to Mr. Gayton A. Douglass and to the Chicago Drainage Commission. In the preparation of maps, I am indebted to several members of the Chicago Drainage Commission; also to the Inland Educator Company for an electrotype of the map of North America.

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THE CHICAGO ACADEMY OF SCIENCES

THE MOLLUSCA OF THE CHICAGO AREA

THE PELECYPODA

BY

FRANK COLLINS BAKER
CURATOR OF THE CHICAGO ACADEMY OF SCIENCES

BULLETIN No. III.
PART I.
OF
THE NATURAL HISTORY SURVEY

ISSUED SEPTEMBER 1, 1898

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LETTER OF TRANSMITTAL.

CHICAGO, ILLINOIS, June 1, 1898.

DEAR SIR:

By direction of the Board of Managers of The Natural History Survey of The Chicago Academy of Sciences, I herewith submit to you for publication, as Part I. of Bulletin No. III. of the Survey, the report on The Mollusca of the Chicago Area, prepared by Frank Collins Baker, Curator of The Chicago Academy of Sciences, to be issued under the rules of the Academy governing such matters.

Respectfully,

WILLIAM K. HIGLEY,
Chairman.

THOMAS C. CHAMBERLIN,
President of The Chicago Academy of Sciences.

The Board of Managers of The Natural History Survey of The Chicago Academy of Sciences:

WILLIAM K. HIGLEY, **Chairman.**
CHARLES S. RADDIN, **Secretary.**
THOMAS C. CHAMBERLIN.
GAYTON A. DOUGLASS.
THOMAS T. JOHNSTON.

THE NATURAL HISTORY SURVEY.

The Mollusca, the title of Bulletin Number III. of The Natural History Survey, will be issued in two parts. The subject of the present report is the Pelecypoda, and a later publication will treat of the Gastropoda.

The work has been prepared by Mr. Frank Collins Baker, Curator of The Chicago Academy of Sciences, who has not only illustrated all species described, by half tones or zinc etchings made from original photographs and drawings, but has also placed in the collection of the Academy a large number of specimens showing the development of and variations in each species found in the area covered by the Survey.

The territory embraced by the publications of the Survey includes Cook and DuPage Counties and the nine north townships of Will County in Illinois, and a portion of Lake County, Indiana. This area gives a surface of about forty-eight or fifty miles square, or a land surface of nearly 1,800 square miles.

All species have been described and keys prepared, in order that the work may be used as a text-book for the local forms of the Mollusca, thus making the subject available to many students who are deterred from pursuing the study because of the high price and rarity of most of the text-books on this subject.

For the reason that Part II. will soon be issued, it has been thought best to withhold the bibliography, glossary and index until the second part is published, and to then make them complete for both parts. It was found that in making the plates, illustrations of three species of Pisidium had been included with a number of gastropods, hence this plate has been reserved for Part II., and the references to it have been made accordingly.

The Board of Managers of the Survey takes pleasure in acknowledging its obligation to Mr. Charles T. Simpson, of the Smithsonian Institution, who not only examined the manuscript of the bulletin, making many valuable suggestions, but reviewed the family Unionidæ and added original matter of his own which is here published for the first time. The board also wishes to express its appreciation of the valuable suggestions that have been made by various conchologists throughout the country, acknowledgment of which has been made by Mr. Baker in the text.

A most attractive feature of the publication is the excellent work done on the photographs, which was made possible by the use of a very valuable camera furnished by Messrs. John Wilkinson and Son, and the skillful work of Mr. Thomas J. Staley, who photographed the shells and developed the negatives.

Finally, it is again a pleasure to make mention of the patrons of The Natural History Survey, whose generosity has tended so much to its success and to make recognition of the arduous labors of Mr. Baker, which have made it possible to issue a work which is most creditable to himself and enables the Survey to make another contribution to the advancement of science.

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ERRATA.

In the generic descriptions of the Unionidæ Mr. Simpson has described both shell and animal. This statement is made in view of the fact that on page 50 Mr. Simpson's name is placed after both shell and animal descriptions, and follows only that of the animal in the descriptions of the other genera.

Page 11, third line, for Glenn read Glen.

Page 17, eighteenth line, for oarolinensis read carolinensis.

Page 17, thirty-sixth line, omit Quadrula pustulata (not found in our area).

Page 18, tenth line, for Quadrula parva read Lampsilis parvus.

Page 18, et al, in place of Elimia use Goniobasis. (See Part II.)

Page 22, No. 117, for complanatus read campanulatus.

Page 23, twenty-seventh line, for decisium read decisum.

Page 23, forty-third line, for albolabris read thyroides.

Page 26, ninth line, for Vitræ read Vitreæ.

Page 28, fifteenth line, for Anadonta read Anodonta.

Page 33, footnote, for Witmerstone read Witmer Stone.

Page 35, No. 24, for Lymnæa read Limnæa.

Page 44, twenty-second line, insert a comma after the word elongated.

Page 44, thirty-fifth line, insert a comma after the word small.

Page 46, last line, for Part I., 1890, read Part III., 1895.

Page 47, fifteenth line, for radiacal read radial.

Page 62, twenty-first line, for fig. 4 read fig. 3.

Page 62, twenty-second line, for Anadonta read Anodonta.

Page 64, twenty-ninth line, for U. read A.

Page 67, ninth line, for pl. xii., read pl. vii.

Page 69, last line, add (Simpson).

Page 73, twenty-fifth line, for bronchiæ read branchiæ.

Page 73, last line, for pressus, read pressa.

Page 103, thirteenth line, omit reference to pl. xxvii (=Anodonta grandis).

Page 111, thirty-first line, add the word "as" after the word laterals.

Page 116, nineteenth line, for Sarratogea, read sarratogea.

Page 120, twenty-seventh line, for sphærium, read Sphærium.

Explanation of plate 27, No. 8, for Sinsley, read Linsley.

INTRODUCTION.

The present volume includes a monographic, illustrated account of all the species of mollusks* which have been collected by various conchologists in the region covered by The Natural History Survey of The Chicago Academy of Sciences. More information regarding the animal, radula, some parts of the anatomy, and habits of the species has been introduced than is generally included in reports of this kind, but it is believed that a work of this nature will be found more useful to those studying this interesting branch of zoölogy. The half-tones are, except when otherwise mentioned, from photographs of the shells made by Mr. Thomas J. Staley, Jr., Assistant to the Curator, and it is hoped that the number of figures given of each species will greatly aid beginners in identifying their collections. A bibliography and a glossary are added.

In the preparation of this work about 20,000 specimens have been examined and several questions of synonymy have been critically surveyed and a satisfactory decision reached, though it is quite probable that many conchologists will not agree with the arrangement of some species, or with the synonymy adopted. In many cases specific limits have been totally misunderstood and sexual and local characters have been adopted as specific. The writer believes, with Mr. Pilsbry, that a species is any form of animal or plant that is not connected with any other *living* animal or plant by intermediate stages. It does not matter how small the character which separates the two forms so long as it is constant. A variety may be considered as simply a modification which is more or less connected by living intermediate forms. The line between a species and a variety, or subspecies is, however, very flexible, and hardly two authors agree as to just what characters shall constitute one or the other.

The keys used in this report apply only to the species as they are found in the area under consideration, although in many cases they will apply equally as well to the same species found in other localities. The measurements of the shells and animals the country is a vast p ... no mollusks are to be found. The whole l ... plaines River is good territory for this class of

---

*It is probable that a number of species will be added to this list in time, although the area has been very carefully and systematically examined during the past ten years.

Bowmanville.—T is the best localities in the entire area. It is si se iles northwest of Chicago near the north branch t Cl River, in Jefferson Township. The region ll w th a forest of large trees, and the ground is ewn eaves and fallen logs and sticks. The fo two llsides sloping to meet a small str i m s o orth branch of the Chicago River. An old woo n crosses this stream is the best single locality. No less en species have been collected beneath this bri th radius of eight feet. The soil in the woods at t l a is oist and generally covered with a thick mould in ich tl llusks love to bury themselves. Twenty-five s cies ve en recorded from this very prolific habitat and more ll obably be found when the ground is more carefully explor .

Wolf, Hyde, Calumet, George and Berry Lakes.—This chain of lakes lies partly in Lake County, Ind., and partly in Cook County, Ill., principally in Hyde Park Township. They are from twelve to eighteen miles from Chicago in a southeasterly direction. The shores about these lakes are generally bare of woodlands, although a small patch of woods occurs here and there which yields an abundant supply of mollusks. These woodlands are moist and, as usual, carpeted with a layer of mould covered with logs. The shores of the lakes are sandy or muddy and are shallow; in fact one may wade across them in many places. The northern portions of these lakes are the best for collecting purposes. At Roby there is a little ditch by the electric car line in which a number of species of Limnæids flourish.

Of the lakes just mentioned, Berry is now thoroughly spoiled as a collecting locality on account of the Standard Oil Works, and by being partly filled up and drained. The timber has also been cut from its shores. This last statement is also true of Hyde and George lakes, the different railroads making embankments through them and cutting the lakes into ditches. Wolf and Calumet lakes are now the only bodies of water left in which good collecting may be done.

Joliet.—This very prolific locality is situated thirty-three miles from Chicago, on the Desplaines River, in Joliet Township, Will County. Numerous small streams empty into the Desplaines in this vicinity and afford excellent localities for molluscan life. The river bottom land is low and swampy, but outside of this the ground is higher and supports a good forest of large trees, affording protection to many species of land snails. The bed of the streams and creeks is composed of a soft, black mud, very conducive to the growth and perfection of mud-loving species, such as Unio and Sphærium. All of the species found here are exceptionally large and fine, owing probably to the large quantity of limestone in the vicinity. The drainage is into the Illinois River via the Desplaines River.

Liverpool, Ind.—This interesting locality is situated twenty-seven miles from Chicago, near Deep River, in Lake County, Indiana. The drainage is into Lake Michigan through the Little and Grand Calumet rivers. The upper part of Deep River sometimes drains into the Desplaines drainage in times of particularly high water. The Little Calumet River runs through low swamps and meadowland, where there is an abundance of black loam and mud. To the east, near Tolleston, there are numerous sand hills on high ground, and to the west an abundance of tall timber on high land. The ground is covered with a rich mould, very conducive to the growth of Helices. Deep and Little Calumet rivers have a muddy bottom and the water is quite deep. Unios (rectus, undulatus, luteolus, etc.) are found here in great abundance and of large size and fine development. Limnæids, Physæ and other fresh water shells thrive abundantly.

Lisle.—This locality is about a mile north of the town of Lisle and lies partly in Lisle and partly in Milton townships. It is twenty-three miles from Chicago. The drainage is by the east branch of the DuPage River into the Desplaines River. The soil is a black loam and the bed of the river is covered with a slimy, black mud. The region is not well wooded. Fresh water mollusks are very abundant.

Evanston Big Woods.—This locality is situated three miles west of North Evanston and thirteen miles north of Chicago. This is the largest patch of woodland in the area, and is noted for its good collecting. The ground in the spring is flooded, making small lakes here and there which abound in mollusks, particularly the genus Sphærium. The ground is carpeted with a heavy mould and is strewn with fallen tree trunks and branches. Nettles also abound and are much sought after by the land shells as food. About two miles east of the are in millimeters and the numerals following the former are the accession numbers of the specimens in the museum of The Chicago Academy of Sciences. In the description of the species, the diagnosis of the shell and animal refers only to specimens found in this area. Distribution and geological distribution signify their dispersal throughout time and space, outside of as well as within our territory. Habitat refers only to the area covered by this report.

The following collections have been examined in preparing these pages: Mr. J. H. Ferriss, Joliet; Mr. T. Jensen, Chicago; Prof. W. K. Higley, Chicago; and the local collection of The Chicago Academy of Sciences, which numbers about 4,000 specimens, representing almost every prominent locality in the area. The writer has personally collected in all parts of the territory, and very few notes of station or locality have been accepted until personally examined. The writings of Messrs. Call, Prime, Pilsbry, Simpson, Tryon, Haldeman, Stimpson, etc., have been freely used for information, and the source of such information has been indicated in the text.

The writer wishes especially to acknowledge his indebtedness to the following persons, who have given him very much valuable assistance and advice:

Prof. Henry A. Pilsbry, Conservator, Conchological Section, Academy of Natural Sciences, of Philadelphia, Penn., who has identified the Amnicolæ, Ancyli, etc.; Mr. Charles T. Simpson, Department of Mollusks, United States National Museum, Washington, D. C., who has revised the Unionidæ, identifying many of them as well as a number of gastropod mollusks; Prof. R. Ellsworth Call, Superintendent of Schools, Lawrenceburg, Ind., who has identified many of the Unionidæ and all the Campelomæ; Dr. V. Sterki, New Philadelphia, Ohio, who has examined the Pupæ, Sphæria and Pisidia, and given valuable notes on their classification. The following persons have also very materially assisted, either by notes, advice or specimens: Mr. Charles W. Johnson, Curator, Wagner Free Institute of Science, Philadelphia, Penn.; Dr. W. S. Strode, Lewistown, Ill.; Mr. Witmer Stone, Conservator, Ornithological Section, Academy of Natural Sciences, of Philadelphia; Messrs. J. H. Ferriss and J. H. Handwerk, Joliet, Ill.; Mr. Paul Bartoch, United States National Museum, Washington, D. C.; Prof. W. K. Higley, Messrs. Frank M. Woodruff, T. Jensen, Paul Favour, Otto Spiedel, C. S. Raddin, C. M. Higginson, W. W. Calkins, Carl

Dilg, Dr. Howard N. Lyon, Miss Grace M. Hall, Mrs. Agnes Chase and Mrs. Lillian M. Baker, Chicago; Mr. B. T. Gault, Glenn Ellyn, Ill.; Prof. Oliver Marcy, Northwestern University, Evanston, Ill.; Mr. Eliot Blackwelder, Morgan Park, Ill., and Mr. Edward H. Baker, of Providence, R. I.

The author's thanks are also due to Messrs. Arthur and John Wilkinson for the use of a valuable camera, with which the plates in this volume were made, and the authorities of the United States National Museum, who kindly opened the way for the examination of a large quantity of material from the collection of The Chicago Academy of Sciences.

I. GENERAL CHARACTERS OF THE MOLLUSCA.

It is very difficult to prepare an exact definition of the Mollusca. That generally given—laterally symmetrical, unjointed body protected by a shell and with a creeping disk, etc.—is hardly correct, since in the majority of forms the lateral symmetry is effaced by torsion (snails) and by attached forms (oyster). The writer would define a mollusk as a body composed of cells which form a double sac, the outer being the body wall and the inner the covering of the digestive tract, the space between these two sacs being a cœlum or blood lymph space. The body is differentiated into a head (prostomium) and a dorsal and ventral surface and right and left sides, thus giving rise, in the more primitive forms, to bilateral symmetry. In all forms there is a creeping disk or foot, which is really the most characteristic part of this group. A pallium or mantle is always present, which secretes, in the shelled forms, the calcareous exoskeleton or shell. The gills (ctenidia) are developments from the body-wall and contain two blood vessels. The nervous system consists of paired ganglia or nerve masses which are more developed about the head than in any other region, and which send off other ganglia with connecting commissures to other parts of the body. The circulatory system consists of a ventricle and one or two auricles, situated within a pericardium. Paired or single nephridia (renal organs) are present, and a more or less complicated reproductive system, which is in many cases hermaphroditic. In one group (Gastropoda) the mouth is provided with a manducatory apparatus (odontophore, radula or tooth bearer).*

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*For an excellent account of the Mollusca, see Lankester, Zoölogical Articles, p. 95, to which the author would acknowledge his indebtedness for much information.

The subkingdom Mollusca is placed by most authors between the worms (Vermes) and the crustaceans and insects (Arthropoda). By some it is considered an offshoot of the worms, and there is, in some respects, a strong similarity in the developmental history of the two subkingdoms. The group is somewhat related to the Vertebrata through the Cephalopoda, where the brain is protected by a cartilaginous covering and the eye is developed to a wonderful degree. The subkingdom is of quite recent date geologically, not appearing in any numbers until the Silurian period. From that time to the present they have greatly increased in numbers; there are at present known about 50,000 living and the same number of fossil species.

II. TOPOGRAPHY OF THE AREA.*

The area in question is one of great interest to the malacologist, since it has been very little written upon and almost nothing is known concerning the extent of its molluscan fauna. The area included is embraced in two drainage systems, one draining into Lake Michigan through the lakes in the southern part of the region and the Chicago River, and one into the Mississippi River through the Desplaines, DuPage, Fox and Illinois rivers. The area includes all of Cook and DuPage counties, the nine northernmost townships of Will County, Illinois, and a small portion of the western part of Lake County, Indiana. The land and water area comprises about twenty-five hundred square miles, or eighteen hundred square miles of land surface. A remarkably low divide runs north and south between the north branch of the Chicago River and the Desplaines River, which at its lowest level is scarcely more than twelve feet above Lake Michigan. It is so low, in fact, that many times during high water the surface water from the Desplaines overflows its banks and runs into Lake Michigan through the north branch of the Chicago River. In this manner numerous species found in the Desplaines River are also found in the small ponds and creeks between it and the lake.

In the southern portion of the region there are five small lakes, lying partly in Cook County, Illinois, and partly in Lake County, Indiana. These are the Calumet (3½x1½ miles), George (2½x$\frac{5}{16}$ miles), Wolf (3x1½ miles), Berry (2x⅛ miles) and Hyde ($1\frac{3}{4} \times \frac{3}{8}$ miles). The lakes are all connected with each other and with Lake Michigan by sluggish bayous and the Calumet River. The entire southeastern region is drained by the Grand Calumet and Little Calumet rivers into Lake Michigan. The northern part of the area is drained into Lake Michigan by the branches of the Chicago River, and the central and western portion is drained into the Illinois River, and finally into the Mississippi by the Desplaines River and its small branches, and the DuPage River with east and west branches, which empties into the Desplaines in the western part of Will County. In the northwestern portion of Cook County there are several small streams which drain into Fox River. Most of the area outside the lake basin has a black prairie soil and the streams are bordered by more or less dense woodlands. "Within the lake basin there is a clay surface upon which are sand and gravel ridges covered with oaks, and between which are swamps and beds of peat." (Higley & Raddin.)

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*For an extended account of the geology and topography of the area, see "The Flora of Cook County, Illinois, and a Part of Lake County, Indiana," by Messrs. Higley and Raddin, and "The Pleistocene Features and Deposits of the Chicago Area," by Frank Leverett.

III. LOCALITIES OF SPECIAL INTEREST.

There are a number of particularly interesting localities in the area, of which the following are the most important:

MORGAN PARK.—Just west of Morgan Park, in the township of Worth, lie a number of sloughs and small ponds in which a variety of species of mollusks abound. The soil here is of a black, clayey loam, from ankle to knee deep. The water in the ponds in summer is from knee to waist deep. The whole country in this region is rolling, the ridges being separated by slough covered prairies. During the spring, when floods occur, the region is converted into a miniature sea. Numerous species of birds gather here to feed upon the mollusks, and the locality is one equally as well suited for the ornithologist as for the conchologist. The drainage is into the Little Calumet River and thence to Lake Michigan.

MAYWOOD.—This locality is situated ten* miles west of Chicago, in Proviso Township, on the Desplaines River. The banks here are from two to fifteen feet in height, and well wooded. The soil consists of a clayey loam, which is covered with dead leaves and sticks. The river is very turbid, the water being contaminated by the sewage which is discharged into the river at several points in the vicinity. West of Maywood the country is a vast prairie upon which no mollusks are to be found. The whole length of the Desplaines River is good territory for this class of animals.

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*These distances are reckoned from the city hall, in the center of the business district of the city.

BOWMANVILLE.—This is one of the best localities in the entire area. It is situated seven miles northwest of Chicago near the north branch of the Chicago River, in Jefferson Township. The region is well wooded with a forest of large trees, and the ground is strewn with dead leaves and fallen logs and sticks. The forest occupies two hillsides sloping to meet a small stream, which empties into the north branch of the Chicago River. An old wooden bridge which crosses this stream is the best single locality. No less than ten species have been collected beneath this bridge within a radius of eight feet. The soil in the woods at this locality is moist and generally covered with a thick mould in which the mollusks love to bury themselves. Twenty-five species have been recorded from this very prolific habitat and more will probably be found when the ground is more carefully explored.

WOLF, HYDE, CALUMET, GEORGE AND BERRY LAKES.—This chain of lakes lies partly in Lake County, Ind., and partly in Cook County, Ill., principally in Hyde Park Township. They are from twelve to eighteen miles from Chicago in a southeasterly direction. The shores about these lakes are generally bare of woodlands, although a small patch of woods occurs here and there which yields an abundant supply of mollusks. These woodlands are moist and, as usual, carpeted with a layer of mould covered with logs. The shores of the lakes are sandy or muddy and are shallow; in fact one may wade across them in many places. The northern portions of these lakes are the best for collecting purposes. At Roby there is a little ditch by the electric car line in which a number of species of Limnæids flourish.

Of the lakes just mentioned, Berry is now thoroughly spoiled as a collecting locality on account of the Standard Oil Works, and by being partly filled up and drained. The timber has also been cut from its shores. This last statement is also true of Hyde and George lakes, the different railroads making embankments through them and cutting the lakes into ditches. Wolf and Calumet lakes are now the only bodies of water left in which good collecting may be done.

JOLIET.—This very prolific locality is situated thirty-three miles from Chicago, on the Desplaines River, in Joliet Township, Will County. Numerous small streams empty into the Desplaines in this vicinity and afford excellent localities for molluscan life. The river bottom land is low and swampy, but outside of this the ground is higher and supports a good forest of large trees, affording protection to many species of land snails. The bed of the streams and creeks is composed of a soft, black mud, very conducive to the growth and perfection of mud-loving species, such as Unio and Sphærium. All of the species found here are exceptionally large and fine, owing probably to the large quantity of limestone in the vicinity. The drainage is into the Illinois River via the Desplaines River.

LIVERPOOL, IND.—This interesting locality is situated twenty-seven miles from Chicago, near Deep River, in Lake County, Indiana. The drainage is into Lake Michigan through the Little and Grand Calumet rivers. The upper part of Deep River sometimes drains into the Desplaines drainage in times of particularly high water. The Little Calumet River runs through low swamps and meadowland, where there is an abundance of black loam and mud. To the east, near Tolleston, there are numerous sand hills on high ground, and to the west an abundance of tall timber on high land. The ground is covered with a rich mould, very conducive to the growth of Helices. Deep and Little Calumet rivers have a muddy bottom and the water is quite deep. Unios (rectus, undulatus, luteolus, etc.) are found here in great abundance and of large size and fine development. Limnæids, Physæ and other fresh water shells thrive abundantly.

LISLE.—This locality is about a mile north of the town of Lisle and lies partly in Lisle and partly in Milton townships. It is twenty-three miles from Chicago. The drainage is by the east branch of the DuPage River into the Desplaines River. The soil is a black loam and the bed of the river is covered with a slimy, black mud. The region is not well wooded. Fresh water mollusks are very abundant.

EVANSTON BIG WOODS.—This locality is situated three miles west of North Evanston and thirteen miles north of Chicago. This is the largest patch of woodland in the area, and is noted for its good collecting. The ground in the spring is flooded, making small lakes here and there which abound in mollusks, particularly the genus Sphærium. The ground is carpeted with a heavy mould and is strewn with fallen tree trunks and branches. Nettles also abound and are much sought after by the land shells as food. About two miles east of the woods there is a small stream in which a great diversity of Physæ may be found.

CALUMET RIVER.—This river runs through Lake County, Indiana, and Thornton and Hyde Park townships, Cook County, Illinois, in a north and westerly direction and empties into Lake Michigan. The only portion in which collections have been made is that part lying in Hyde Park Township. It is from eleven to fifteen miles from Chicago. The banks are muddy and at the present time are denuded of woodlands. The water is of considerable depth, but along the shores there are shallows in which mollusks are numerous.

Other good points which may be mentioned are Avondale, Edgebrook, Blue Island, Riverdale, the south branch of the Chicago River, Riverside, Dunning, Lemont, Hickory Creek, Rock Run, the Illinois and Michigan Canal, Naperville, Lockport, Willow Springs, Romeo, Salt Creek and Thorn Creek.

In several parts of the area under discussion the natural drainage has been much affected by artificial canals; in the southern region the old canal feeder connects the Desplaines River with Stony Creek, which causes the waters of the Little Calumet River to mingle with those of the Desplaines River. In the middle of the area the waters of the Illinois and Michigan Canal and the south branch of the Chicago River mingle with the waters of the Desplaines River and Lake Michigan. These facts probably account to some extent for the similarity of the Mississippi Valley and Great Lake faunæ.

IV. GEOGRAPHICAL DISTRIBUTION.

The geographical distribution of the species
area is interesting. The present lakes and ponds
are the relics of the glacial period and were onc
the area of Lake Michigan, or Lake Chicago,
geologically (Fig. 1). The receding of the
peculiar distribution of the molluscan fauna, esp
snails. Thus we find that there are certain spe
northern part of the area which are not found
part, and vice versa. Polygyra albolabris, P.
idula solitaria and Pupa fallax are not foun
region, but are abundant in the southern reg
Planorbis campanulatus and P. bicarinatus wh
south, but so far as known, absent north.

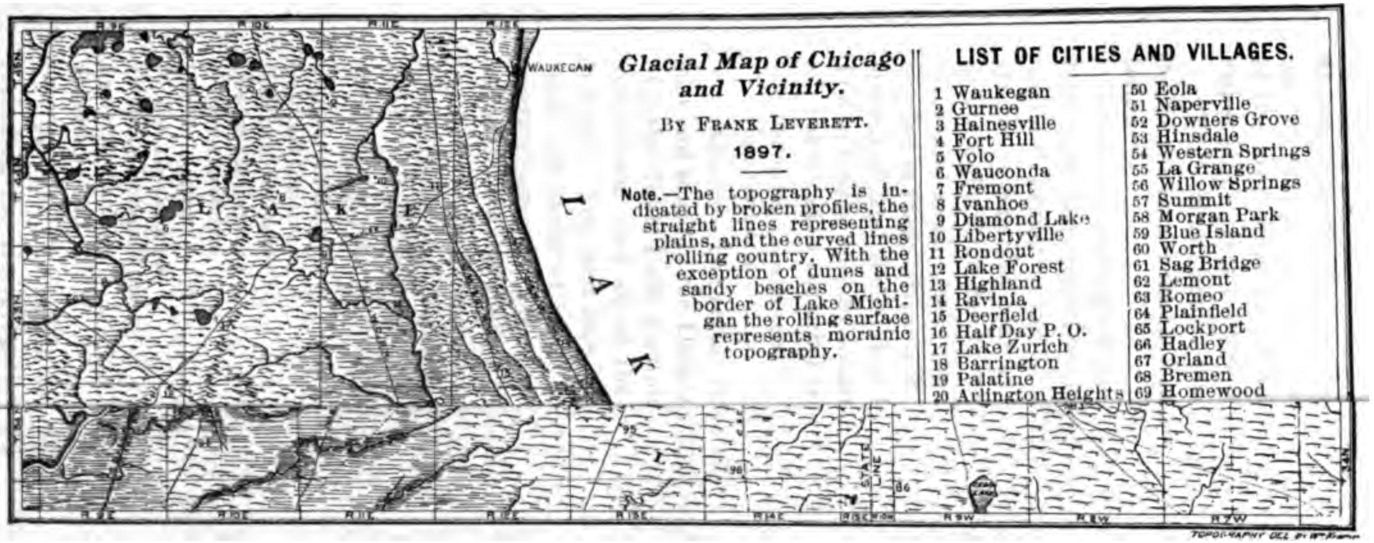

Fig. 1.

"Explanation of Glacial Map of Chicago and Vicinity.—On this map an attempt is made to give a bird's-eye view of the area by means of broken profiles. The moraines appear with undulating contour, the plains with straight lines, the beaches with abrupt, step-like descent of the plain. Striæ are indicated by arrows and represent bearings accurately. Some confusion of dunes with moraines may arise if it is not borne in mind that the belt of ridges bordering Lake Michigan in Lake County, Indiana, consists of sand dunes. The dunes are found for eight to twelve miles south from the lake in that county. The bars in Cook County, Illinois, also are to be distinguished from the moraines. They are much lower and narrower ridges, as shown in the discussion."—*Leverett, Pleistocene Features, p. 23, pl. iii, 1897.*

abundant south, but are generally absent north, and the same may be said of the Sphæria and Pisidia. In the western part of the area there are several species which are not found in either of the other two regions.

The writer, from a study of the material at hand, would divide the area embraced in the survey into three regions, as follows:

FIRST.—The region lying north of the mouth of the Chicago River and east of the Desplaines River, including in its territory the north branch of the Chicago River and its tributaries. The ground is generally high and free from swamps. The drainage is into Lake Michigan by the Chicago River principally, but also by several small creeks about Evanston. The district is heavily wooded in many places and is especially favorable to the development of land shells; but few fresh-water species are found. The following species inhabit this region and, so far as known, are not found in the other regions:

Philomycus oarolinensis.
Pupa corticaria.
Limnæa columella.

SECOND.—The region lying south of the Chicago River and east and south of the Desplaines River, including the townships of Lake, Hyde Park, Calumet, Worth, Bremen, Thornton, Rich and Bloom, and all of the territorial region in Lake County, Indiana. The land here is generally low and swampy and contains the chain of lakes before mentioned. Woodlands are scattered about and the region is equally as well suited for land as for fresh-water shells. The drainage is into Lake Michigan through the small lakes and the Grand and Little Calumet rivers. The Illinois and Michigan Canal somewhat mingles the two systems of drainages. Unios are particularly abundant. The species tabulated below appear to be peculiar to this region.

Obliquaria reflexa.
Quadrula trigona.
Quadrula verrucosa.
Quadrula lachrymosa.
Quadrula pustulata.
Plagiola elegans.
Plagiola donaciformis.
Lampsilis multiradiatus.
Lampsilis gracilis.
Sphærium fabale.
Polygyra inflecta.
Polygyra tridentata.
Gastrodonta ligera.
Gastrodonta demissa.
Physa ancillaria.
Pleurocera subulare.
Campeloma ponderosum.

THIRD.—The region lying west of the Desplaines River, including the river, together with the townships of Palos, Or-land, Frankfort, Lemont, Homer, New Lenox, Lockport and Joliet. The territory consists principally of rolling prairies; swamps, except near the rivers, are absent. The drainage is into the Illinois, thence to the Mississippi River through the DuPage, Desplaines and tributaries of the Fox rivers. Woodlands are found along the river banks which afford a retreat for the land snails. The fresh-water forms are abundant. The following species are peculiar to this region:

Anodonta imbecilis.
Quadrula parva.
Quadrula plicata.
Quadrula coccinea.
Alasmodonta pressa.
Unio hildrethianus.
Lampsilis anodontoides.
Lampsilis ligamentinus.
Lampsilis spatulatus.
Sphærium transversum.
Sphærium truncatum.
Sphærium securum.
Pisidium politum.
Omphalina fuliginosa.
Vallonia parvula.
Pupa procera.
Pupa holzingeri.
Pleurocera elevatum intensum.
Elimia livescens depygis.

We find the following species to be equally distributed throughout our area:

Anodonta grandis.
Anodontoides subcylindraceus.
Strophitus edentulus.
Alasmodonta complanata.
Lampsilis luteolus.
Unio gibbosus.
Quadrula rubiginosa.
Quadrula undulata.
Sphærium stamineum.
Sphærium striatinum.
Sphærium partumeium.
Pisidium abditum.
Vitrea arborea.
Vitrea hammonis.
Vitrea indentata.
Conulus fulvus.
Gastrodonta nitida.
Gastrodonta minuscula.
Limax campestris.
Pyramidula alternata.
Pyramidula striatella.
Pyramidula lineata.
Vallonia pulchella.
Polygyra thyroides.
Polygyra profunda.
Polygyra hirsuta.
Pupa contracta.
Pupa curvidens.
Succinea obliqua.
Succinea avara.
Succinea ovalis.
Carychium exiguum.
Carychium exile.
Limnæa desidiosa.
Limnæa humilis.
Limnæa caperata.
Limnæa cubensis.
Limnæa palustris.
Limnæa palustris michiganensis.
Limnæa reflexa.
Planorbis trivolvis.
Planorbis parvus.
Segmentina armigera.
Ancylus rivularis.
Physa heterostropha.
Aplexa hypnorum.
Pleurocera elevatum.
Elimia livescens.
Amnicola limosa.
Valvata tricarinata.
Vivipara contectoides.
Campeloma rufum.
Campeloma decisum.
Campeloma subsolidum.

TABLE SHOWING THE COMPARATIVE DISTRIBUTION OF SPECIES.

	NORTHERN REGION. LAKE DRAINAGE.											SOUTHERN REGION. LAKE DRAINAGE.																				WESTERN REGION. MISSISSIPPI RIVER DRAINAGE.														
SPECIES.	Winnetka.	Evanston.	Bowmanville.	N. Br. Chi. Riv.	Buena Park.	Wheeling.	Lincoln Park.	Edgebrook.	Avondale	BohemianCem.	Lake Shore.	Wolf Lake.	Calumet Lake.	Hyde Lake.	Berry Lake.	George Lake.	Roby.	Mud Lake.	Liverpool.	Calumet River.	Little Cal. R.	Lake Shore.	Sheffield.	Hammond.	Blue Island.	Miller's.	Washington Pk.	Riverdale.	Morgan Park.	S. Br. Chi. Riv.	Thorn Creek.	Maywood.	Riverside.	Dunning.	Lemont.	Milton T'w'p.	Joliet.	Hickory Creek.	DuPage River.	Willow Sp'gs.	Lisle T'w'p.	Rock Run.	Bird's Bridge. DuPage Feeder	Troy T'w'p.	Naperville.	Salt Creek.
1. Anodonta grandis		*		*			*												*	*	*					*					*			*		*				*						
2. " footiana	*			*											*	*		*		*											*															
3. " imbecilis																																								*						
4. Alasmodonta complanata				*															*		*									*	*		*	*				*		*						*
5. " rugosa																															*			*				*		*						*
6. " pressa																																		*		*		*		*						
7. " marginata												*	*								*												*	*				*								
8. " deltoidea												*																										*								
9. Strophitus edentulus				*							*		*									*														*		*								
10. " pavonius																																*					*	*								
11. Unio gibbosus	*											*	*		*					*	*	*									*	*	*	*					*							*
12. " hildrethianus																																						*								
13. Anodontoides ferussacianus				*																						*								*		*		*								
14. " subcylindraceus				*							*				*																							*		*						
15. Quadrula trigona																				*																										
16. " rubiginosa				*															*		*									*	*		*	*					*	*						*
17. " coccinea																																		*					*	*						
18. " plicata																																								*						
19. " undulata				*																	*									*	*			*						*						*
20. " lachrymosa																					*									*	*															
21. " verrucosa																				*	*																									
22. " pustulosa													*							*																	*									
23. Obliquaria reflexa																				*																										
24. Plagiola donaciformis																				*																										
25. " elegans																				*	*										*															
26. Lampsilis ventricosus																					*			*	*					*	*							*								
27. " multiradiatus												*		*																																
28. " alatus																				*																										
29. " gracilis																					*										*									*						
30. " anodontoides																																						*								
31. " rectus																			*		*																	*	*							
32. " luteolus		*				*					*	*	*		*				*		*	*	*			*				*	*		*	*		*	*	*	*	*	*					*
33. " iris												*		*							*													*					*	*						
34. " spatulatus																														*						*			*							*
35. " ligamentinus																																	*						*							
36. " parvus																																		*		*			*	*						
37. Sphærium solidulum											*																											*								
38. " stamineum				*																*					*							*	*	*		*		*								
39. " simile																				*						*												*		*						

TABLE SHOWING THE COMPARATIVE DISTRIBUTION OF SPECIES.—CONTINUED.

	NORTHERN REGION. LAKE DRAINAGE.											SOUTHERN REGION. LAKE DRAINAGE.																				WESTERN REGION. MISSISSIPPI RIVER DRAINAGE.														
SPECIES.	Winnetka.	Evanston.	Bowmanville.	N. Br. Chi. Riv.	Buena Park.	Wheeling.	Lincoln Park.	Edgebrook.	Avondale.	BohemianCem.	Lake Shore.	Wolf Lake.	Calumet Lake.	Hyde Lake.	Berry Lake.	George Lake.	Roby.	Mud Lake.	Liverpool.	Calumet River.	Little Cal. R.	Lake Shore.	Sheffield.	Hammond.	Blue Island.	Miller's.	Washington Pk.	Riverdale.	Morgan Park.	S. Br. Chi. Riv	Thorn Creek.	Maywood.	Riverside.	Dunning.	Lemont.	Milton T'w'p.	Joliet.	Hickory Creek.	DuPage River.	Willow Sp'gs.	Lisle T'w'p.	Rock Run.	Bird's Bridge. DuPage Feeder	Troy T'w'p.	Naperville.	Salt Creek.
40. Sphærium striatinum				*											*					*																		*		*						
41. " fabale																										*																				
42. " occidentale		*													*																								*							
43. Calyculina transversa							*																									*						*		*						
44. " truncata																																							*							
45. " securis																																										*				
46. " partumeia		*											*																										*			*				
47. Pisidium abditum				*											*											*												*		*						
48. " virginicum															*																									*						
49. " compressum															*																							*	*							
50. " politum																																					*									
51. Vallonia pulchella															*																						*								*	
52. " costata																									*																					
53. " parvula																																											*			
54. Polygyra inflecta																										*																				
55. " tridentata															*																															
56. " fraudulenta																										*									*											
57. " profunda			*									*																				*			*		*									
58. " albolabris													*											*													*									
59. " exoleta													*																							*										
60. " thyroides	*		*	*	*								*																								*									
61. " clausa																					*												*				*									
62. " pennsylvanica																					*			*													*					*				
63. " multilineata																				*	*											*			*		*									
64. " hirsuta			*						*					*																							*									
65. " monodon		*																																			*									
65a. " " fraterna																																	*				*									
66. " leai												*									*							*	*					*			*			*						
67. Strobilops labyrinthica	*	*						*																								*														
68. Pupa fallax															*						*																*					*				
69. Bifidaria corticaria			*						*																																					
70. " procera																																					*						*			
71. " armifera															*																		*				*									
72. " contracta			*		*			*		*		*																									*									
73. " holzingeri																																					*									
74. " pentodon								*																													*									
75. " curvidens								*				*																									*									
76. Vertigo milium			*					*																								*	*				*									
77. " ovata	*																															*	*				*									
78. Cochliopa lubrica			*					*	*			*																																	

TABLE SHOWING THE COMPARATIVE DISTRIBUTION OF SPECIES—CONTINUED.

SPECIES.	NORTHERN REGION. LAKE DRAINAGE.												SOUTHERN REGION. LAKE DRAINAGE.																					WESTERN REGION. MISSISSIPPI RIVER DRAINAGE.																
	Winnetka.	Evanston.	Bowmanville.	N. Br. Chi. Riv.	Buena Park.	Wheeling.	Lincoln Park.	Edgebrook.	Avondale.	BohemianCem.	Lake View.	Lake Shore.	Wolf Lake.	Calumet Lake.	Hyde Lake.	Berry Lake.	George Lake.	Roby.	Mud Lake.	Liverpool.	Calumet River.	Little Cal. R.	Lake Shore.	Sheffield.	Hammond.	Blue Island.	Miller's.	Washington Pk.	Riverdale.	Morgan Park.	Worth.	Pine Station.	S. Br. Ch. Riv.	Maywood.	Riverside.	Dunning.	Lemont.	Milton T'w'p.	Joliet.	Hickory Creek.	DuPage River.	Willow Sp'gs.	Lisle T'w'p.	Rock Run.	Bird's Bridge.	Ill.& Mich.Can.	Naperville.	Lockport.	Romeo.	Salt Creek.
79. Testacella haliotoidea							*																																											
80. Circinaria concava		*	*					*																										*					*											
81. Omphalina fuliginosa																																		*																
82. Vitrea cellaria.							*																					*																						
83. " hammonis.		*	*	*				*					*			*				*																			*											
84. " indentata.		*	*	*	*								*														*												*											
85. Conulus fulvus.	*	*	*		*			*					*							*																			*											
86. Zonitoides nitidus.				*				*	*							*																		*	*				*											
87. " arboreus.	*	*	*	*	*			*	*	*		*	*	*		*				*										*	*							*		*				*						*	*	*
88 " minusculus.		*	*	*				*	*				*																					*	*									*						
89. Gastrodonta ligera													*																																				
90. " demissa.													*																																				
91. Limax maximus							*																																										
92. " flavus.							*																																										
93. Agriolimax campestris.		*	*		*		*			*		*	*	*	*	*	*											*	*	*				*	*	*	*		*					*						*
94. Philomycus carolinensis			*																																														
95. Pyramidula alternata		*	*	*	*				*							*																		*					*											
96. " solitaria																*														*									*											
97. " striatella	*		*					*					*			*																							*											
98. Helicodiscus lineatus	*	*			*								*		*																							*											
99. Punctum pygmæum		*						*																																									
100. Succinea obliqua.	*	*	*						*						*	*																						*											
101. " retusa.			*										*			*				*							*												*											
102. " avara			*	*									*																									*											
103. Carychium exiguum.		*	*					*					*																					*					*											
104. " exile.								*								*																							*											
105. Limnæa columella							*																																										
106. " catascopium		*										*									*							*																						
107. " desidiosa			*	*			*				*					*	*		*											*				*					*					*						
108. " humilis.							*							*	*	*	*	*		*							*			*				*					*											*
109. " caperata		*	*											*				*																*					*											
110. " cubensis			*											*				*												*									*											
111. " palustris			*	*							*	*	*	*	*	*	*	*			*		*	*			*	*			*	*							*			*		*		*				
111a. " " michiganensis			*								*	*		*	*			*			*											*							*											
112. " reflexa											*	*				*	*	*	*		*						*			*	*								*											*
112a. " " attenuata																																							*											
113 " stagnalis.													*	*	*						*																		*			*								

TABLE SHOWING THE COMPARATIVE DISTRIBUTION OF SPECIES—CONTINUED.

SPECIES.	NORTHERN REGION. LAKE DRAINAGE.												SOUTHERN REGION. LAKE DRAINAGE.																					WESTERN REGION. MISSISSIPPI RIVER DRAINAGE.																
	Winnetka.	Evanston.	Bowmanville.	N. Br. Chi. Riv.	Buena Park.	Wheeling.	Lincoln Park.	Edgebrook.	Avondale.	BohemianCem.	Lake View.	Lake Shore.	Wolf Lake.	Calumet Lake.	Hyde Lake.	Berry Lake.	George Lake.	Roby.	Mud Lake.	Liverpool.	Calumet River.	Little Cal. R.	Lake Shore.	Sheffield.	Hammond.	Blue Island.	Miller's.	Washington Pk.	Riverdale.	Morgan Park.	Worth.	Pine Station.	S. Br. Chi. Riv.	Maywood.	Riverside.	Dunning.	Lemont.	Milton T'w'p.	Joliet.	Hickory Creek.	DuPage River.	Willow Sp'gs.	Lisle T'w'p.	Rock Run.	Bird's Bridge.	Ill.& Mich.Can.	Naperville.	Lockport.	Romeo.	Salt Creek.
114. Planorbis trivolvis	*		*	*							*	*	*	*	*	*	*	*			*					*			*	*	*		*	*	*	*	*		*				*							*
115. " truncatus				*							*						*									*																								
116. " bicarinatus													*			*	*				*													*			*		*			*	*							
117. " complanatus													*	*		*	*				*														*				*			*								
118. " exacutus														*									*										*						*											
119. " parvus											*			*	*		*			*																			*			*								*
120. " deflectus																										*													*			*								
121. Segmentina armigera				*									*	*	*		*	*	*			*				*			*					*					*			*								
122. Ancylus rivularis							*													*																*			*			*								*
123. " tardus																																									*									
124. " shimekii																																												*	*					
125. Physa heterostropha	*	*	*	*							*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*		*
126. " ancillaria														*		*																																		
127. Aplexa hypnorum		*											*	*	*	*	*																						*											
128. Pleurocera subulare													*																																					
128a. " " intensum																																				*														
129. " elevatum				*								*	*	*							*	*	*												*	*			*											
129a. " " lewisii																					*																		*											
130. Elimia livescens		*										*	*	*							*	*														*			*	*										
130a. " " depygis																																								*										
131. Bythinia tentaculata	*										*																																							
132. Amnicola limosa				*										*		*											*						*	*		*					*	*								*
133. " lustrica																*																				*														
134. Cincinnatia cincinnatiensis				*								*																								*					*	*								*
135. " obtusa				*							*												*				*														*									
136. Bythinella nickliniana																*																										*								
137. Somatogyrus subglobosus																	*					*																	*			*								
138. " integer																					*																			*										
139. Pomatiopsis cincinnatiensis																																							*	*				*						
140. " lapidaria														*																			*						*	*				*						
141. Valvata sincera				*							*												*				*						*																	
142. " tricarinata				*											*								*										*									*		*						
143. Vivipara contectoides				*									*	*																			*		*				*					*						
144. Campeloma ponderosum																					*																													
145. " rufum				*										*							*												*	*	*	*				*	*									*
146. " decisum				*									*			*				*	*			*							*			*	*	*														*
147. " subsolidum		*	*										*	*		*					*												*	*		*				*	*									

V. GEOLOGICAL DISTRIBUTION.

The geological distribution of the land and fresh-water species in the area is but imperfectly known. The shells of Unio, Elimia, Limnæa, Planorbis and Ancylus have been found in considerable abundance in the beach at Evanston, near the University. In the township of Worth, three miles west of Morgan Park, the shells of Limnæa, Planorbis and Physa have been found buried to the depth of several feet, and the specimens were perfectly preserved. The following species have been found and are in the collection of the Academy:

Quadrula trigona—Corner Wrightwood Avenue and North Clark Street; excavations for building.

Quadrula undulata—Corner Frederick and North Clark Streets; excavations for building.

Quadrula sp. (apparently between trigona and rubiginosa)—Hall Street; excavations for building.

Polygyra thyroides—Foot of Argyle Street, near the Lake.
Limnæa caperata—Worth.
Limnæa cubensis--Worth.
Limnæa palustris—Worth.
Limnæa reflexa--Worth, and foot of Argyle Street.
Limnæa stagnalis—Near Calumet Lake.
Physa heterostropha—Worth.
Pleurocera elevatum—In beach, corner Sheffield and Lincoln Avenues.
Elimia livescens—In beach, corner Sheffield and Lincoln Avenues.
Elimia livescens—In beach, Balmoral Avenue north of Bowmanville.
Campeloma decisium—Near Calumet Lake.

At Willow Springs, in the river bank, the following species were collected by Mr. Jensen:

Anodonta grandis.
Unio gibbosus.
Quadrula rubiginosa.
Sphærium stamineum.
Sphærium simile.
Planorbis trivolvis.
Physa heterostropha.
Cincinnatia obtusa.
Cincinnatia cincinnatiensis.
Amnicola limosa.

In the sand banks east of Sheridan Drive and north of Graceland Avenue, Mr. Jensen collected the following species:

Sphærium striatinum.
Pisidium virginicum.
Limnæa desidiosa.
Limnæa cubensis.
Planorbis bicarinatus.
Elimia livescens.
Somatogyrus subglobosus.
Campeloma subsolidum.

The same collector found the following species in a subfossil condition (buried in loam) at Bowmanville:

Polygyra albolabris.
Polygyra profunda.
Pyramidula alternata.

At Evanston, in the beach near The Northwestern University, the following species have been collected by Prof. Oliver Marcy:

Unio of various species.
Limnæa palustris.
Limnæa caperata.
Limnæa reflexa.
Planorbis trivolvis.
Physa heterostropha.
Ancylus sp.
Elimia livescens.
Pleurocera elevatum.

The fossils are sometimes found in clay and sometimes in carbonaceous earth. The following section* shows the general position of the strata in relation to the fossils:

SECTION OF BEACH AT EVANSTON MADE IN 1864.

		FEET.
1.	Surface soil, sandy	1½
2.	Brown sand and fine gravel	2½
3.	Coarser gravel, stratified	2½
4.	Fine sand	2
5.	Gravel, containing bones of deer	1⅓
6.	Fine sand, containing oak logs	1½
7.	Peat or carbonaceous earth with a marl bed containing molluscan shells in the lower portion or interstratified with the peat	1½
8.	Gravel	3¼
9.	Humus soil, with stumps and logs (coniferous)	½
10.	Yellow clay, laminated and contorted, containing pockets of gravel	3½
11.	Blue, pebbly clay	2
	Height of bluff	22

Mr. Carl Dilg has found a number of fossil shells in excavations for the foundations of flat buildings and has made collections at the corner of Wrightwood Avenue and Clark Street, corner of Frederick and Clark Streets, on Hall Street, corner Sheffield and Lincoln Avenues and on Balmoral Avenue south of Bowmanville. The genera found were Unio, Pleurocera and Elimia.

It is probable that many additional species of fossil mollusks will be found when the area is more systematically surveyed for this purpose.

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*From Leverett, after Marcy, Pleistocene Features, p. 76.

VI. INSTRUCTIONS FOR COLLECTING MOLLUSKS.*

Before proceeding to discuss the particular species found within the limits of the area, it may not be out of place to briefly consider the methods of collecting and preserving specimens of this group.† Mollusks may be found in all parts of Illinois in almost every situation; in the woodlands, the swamps, the creeks and rivers and the lakes. Even the prairies have given us several species of this type. For convenience we will divide the group into two sections, viz.: 1. Land species. 2. Fresh-water species.

I. LAND SPECIES.

The land mollusks cover a variety of widely separated forms; some are with, others without shells; some are herbivorous and others are carnivorous.

a. HABITAT.—Land mollusks exist under almost all conditions. In an old forest they will be found under dead leaves and decaying logs. The bark of old trees which is "starting," and old, rotting stumps will be found prolific collecting stations. The shelter of loose stones and boulders is also good ground for these animals. Other forms live on the leaves of sedges, grass and shrubbery. During the winter months these animals bury themselves in the soil at the base of these grasses and shrubs. A limestone region is the most conducive to the life and growth of land snails, and in this kind of a region they are very plentiful, while in a country composed of quartz (flint) they will not thrive and are seldom found. Where coniferous or resinous trees abound few if any mollusks will be found, while in a locality made up of deciduous or soft-wooded trees the snail fauna will be abundant and varied. Pungent herbs are inimical to snails, while the nettles are favorite localities for them. No pulmonate mollusk will live where sand, ashes or lime in a pure state are found.

The spring months are the best suited for the active life of snails, but it is not until midsummer that they reach their maximum development. During the winter months they bury themselves in the ground, closing the aperture of the shell with a leathery secretion called an epiphragm; the naked slugs cover

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*For much of the information used in this topic the author is indebted to Dr. Wm. H. Dall's "Instructions for Collecting Mollusks, and Other Useful Hints for the Conchologist," being part G of Bull. No. 39, U. S. National Museum.

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†The writer has inserted this topic for the reason that works upon this subject are not always to be obtained, and principally so that the reader of this report might have all the necessary information before him without consulting other works.

themselves with this secretion much as a caterpillar does with a cocoon. Many times several epiphragms will be found in a single snail. Most land mollusks live but two or three years, although some exotic forms, like the desert snails of Africa, live for a much longer time.

b. COLLECTING OUTFIT.—Among the most useful collecting tools needed may be mentioned a pair of small spring forceps; the points should be slender and meet together perfectly. They are indispensable in picking up minute Pupæ and Vitræ, as well as for sorting over the collection after the day's work. The common homœopathic vial is also an invaluable adjunct to store small forms as collected. The cork, however, should be attached to the neck of the vial by a thread, so that it will not be lost in the underbrush. A couple of wide mouthed two ounce bottles serve well for large species. A tin box, like a mustard box, which fits the pocket well, is often found very useful to carry snails the size of Polygyra thyroides; care should be used in putting the snails in the box or they will get broken. A piece of cotton in the bottom of the can will prevent this. When the small species like Pupa and Vitrea are desired simply for their shells, it will be a good plan to fill the homœopathic vials half full of thirty per cent. alcohol. This will abstract the moisture and keep away any offensive smell which might arise from them. This also prevents them from adhering to the sides of the bottle and to themselves, when it is a difficult matter to remove them without breaking. In collecting species inhabiting bushes, an insect net will be found of great value in which to catch them as the bushes are shaken. The writer has used an open umbrella, inverted, for the same purpose. A small trowel and a large knife are always of great use in digging about rotten logs and tearing the bark from decaying trees. A pocket lens of about ten diameters is an invaluable addition to a collector's outfit, and a large reading glass is very useful in aiding in the preliminary sorting of the day's catch. A stout wooden rake with a long handle will be found of great value in raking hillsides and under bushes.

c. FAVORABLE LOCALITIES.—Pulmonate mollusks may be looked for in the following localities: The under surface of old, weather-worn pieces of board, bones or leather; the earth about rotting stumps and under stones and fallen logs; moist moss under rocks; under overhanging ledges; in marshes and the margins of brooks and ponds. If the débris left by freshets along the borders of a stream be examined it will frequently yield a rich harvest of small snails. In other words any cool place where there is plenty of shelter and moisture will be found a good locality for these animals. In forests mollusks will be found abundantly where soil is plentiful and where there are numerous open spots. They will not be found in woodlands of spruce or pine.

When search is being carried on for the animals and shells the eggs should not be forgotten, for they are of great importance. These will be found in about the same localities as the mollusks themselves, in cool, moist places. They may be known by their white color, leathery texture and the pellucid membrane in which they are enclosed. They resemble little balls of jelly, and are generally found in a mass, although deposited singly. Since the embryological development of but few mollusks is known, any careful student may find here a wide field for original investigation.

If it is found desirable to keep some of the animals alive they may be put in a box filled with moist earth. A large fish globe is very useful for this purpose. Everything done by the animals should be noted, especially the manner of eating and kind of food taken.

2. FRESH-WATER SPECIES.

Both gastropods and pelecypods are found in fresh water. Any region having ponds, streams, ditches, brooks, etc., will support a fresh-water molluscan fauna.

a. HABITAT.—A body of water with a quantity of lime in solution and with a muddy bottom will yield the largest variety of mollusks, since lime is essential to the building up of the shell. A coarse crystalline gravel is less adapted to them than is soft, less gritty sands and mud.

A rapid current is not favorable, although a number of mollusks (as the Pleuroceridæ) are found on rocks over which a rapid stream is flowing. A stream filled with decaying vegetation is unsuited to molluscan life from the presence of carbonic acid (CO_2) arising from its decay. This not only affects the life of the animal, but causes an excessive erosion of the shell, in the repair of which the animal is weakened by the enforced secretion of shelly matter.

Gill-bearing mollusks will not voluntarily inhabit a stream holding impalpable mud in suspension, nor in waters charged with salts of various kinds. Many times, however, some hardy species survive in even brackish water; the effect of such a habitat is to dwarf and otherwise distort the shell. Some salt water species are known to inhabit both brackish and fresh water.

The small bivalves, Pisidium and Sphærium, prefer mountain pools, wet meadows, ponds and ditches. Anodonta prefers large ponds and slow moving streams, while the stouter Unio lives best on a hard, rocky bottom; in sandy bottoms they may be seen pushing themselves about quite rapidly. In ponds and sluggish streams the genera Physa, Limnæa, Planorbis and Amnicola are found abundantly. Lily pads are good habitats for small mollusks, as are also the roots of trees and blades of swamp grass.

b. COLLECTING OUTFIT.—A fish basket makes a good collecting receptacle. A large basket is invaluable to carry the larger species like Unio and Anadonta. A dip net will be found useful to dredge for those species which inhabit a muddy bottom. The small or minute species may be put in small vials, as mentioned for land shells. A flat bladed knife, or small trowel, and a pair of tweezers will complete the outfit. A scoop made of fine wire gauze will make a useful dredge to scoop the mud of shallow ponds and rivers.

A small dredge, similar to those used in deep sea dredging, is of great value in collecting in the larger lakes. A strong man, or better, two men should row the boat and the one having charge of the dredge should be ever on the alert for obstructions on the bottom so that the dredge may not be damaged. A lead should be prepared with a hollow base in which to place some kind of grease to ascertain the character of the bottom, whether sandy or muddy, and should be attached to a stout line marked off in feet, to record the depth. These points should always be carefully noted with each haul, together with the distance from the shore.

c. FAVORABLE LOCALITIES.—In (*a*) a number of good localities have been given. Muskrat burrows are always good localities for the Unionidæ and the shells may frequently be found perfectly cleaned. The drift along the shore will yield a goodly number. As spoken of under land shells, so with fresh-water species, the eggs should be collected and preserved for study during development. These resemble drops of transparent jelly. For the preservation and study of the eggs, as well as small forms of adult mollusks, a small fish globe will serve as an excellent aquarium. Any jar of medium size will do equally as well, however, and even a good sized tumbler will answer the purpose.

Care should be taken to record all observations, as much information is needed concerning the embryological development of the fresh-water mollusks.

3. PRESERVATION OF COLLECTIONS.

The preservation of the collections obtained on each day's trip is of great importance, for upon this depends the appearance and value of the collector's cabinet. When the specimens are collected they are covered with mud and growths of various kinds, and must be thoroughly cleaned. In the case of land and fresh-water shells, they should first be washed clean of mud, etc.; this may be rendered easier by the aid of a toothbrush. The soft parts may be removed by putting the animal for a few seconds in boiling water. If they are first placed in lukewarm water for a few minutes and then transferred to the boiling water it will prevent cracking and preserve the polish which is frequently lost when delicate shells are immediately placed in boiling water. The animal may be extracted from the shell with a crooked pin or wire, or better still, a small pair of tweezers. Those species having an operculum should have it carefully removed and attached to a piece of cotton, which may be placed in the aperture of the shell. Some opercula warp out of shape while drying, and it will be found a good rule to place them between two boards during this process. Some of the shells may be covered with incrustations of lime and peroxide of iron, and to remove these an old file or small bone scraper will be found useful. The file should be ground to a point. Naked mollusks (slugs) may be preserved in alcohol or formalin. The internal shell of Limax may be extracted and preserved if desirable, but the better method is to prepare the whole animal. Shells that are stained with iron or other matter may be perfectly cleaned by placing for a few moments in a solution of oxalic acid.

Unios and other bivalves should have the animal removed with a flat-bladed knife. To do this the two adductor muscles must be cut, after which the valves will open and the animal may be entirely cut away. If the shells are left in the sun for a few hours they will gape and the animal may then be easily removed. The two valves should be tied together in their natural position. Care should be used in cleaning the shell so that the hinge ligament will not be injured. In the case of shells having an epidermis, they may be greased with vaseline to prevent cracking when dry. Care should be used not to apply it in too large quantities or the shells will feel greasy. After applying the vaseline it should be thoroughly rubbed in with a flannel rag and all surplus grease removed. Small gastropods need not be removed from the shell, but may be put in alcohol for fifteen or twenty minutes, after which they may be dried and placed in the cabinet. The collector will undoubtedly find numerous ways of improving his cleaning and preserving methods, as experience dictates.

The methods of labeling need not be dwelt upon here. All manner of schemes are used by conchologists in mounting and preparing specimens for the cabinet. Some use cardboard labels with a space for the specimens and another for the name, etc.; others simply use pasteboard trays, allowing the shells to remain loose instead of attaching them as in the case of the cardboard tablets. In the collections of The Chicago Academy of Sciences all specimens are attached to these tablets and they present a handsome appearance; but this is hardly feasible for the cabinet of a private collector, for lack of room. A good cabinet of drawers three inches in depth will suffice for most of the land and fresh-water shells, although several deeper drawers may be found useful for large unios. In writing the labels the generic and specific names and the authority for the name should occupy the first line, and the locality and name of the person from whom the specimens were received may occupy the balance of the label; the bottom of the latter might be used to advantage for short notes relating to the habits or peculiarities of the individuals in the tray.

The following sample shows the manner of doing this:

No. 197. Sex ♂ Date 6-14-95.
UNIO LUTEOLUS Lamarck.
Set showing variation due to age.
Calumet Lake near Pullman.
Coll. by John Smith.

Found in a muddy bottom on a sloping shore,
in two feet of water. Specimens plentiful.

It is always a good idea to keep a catalogue of the collection. Each tray of specimens should be numbered and entered in the catalogue, together with all possible information. A card catalogue is also of great value.

4. PRESERVATION FOR ANATOMICAL USE.*

It is sometimes desirable to preserve the soft parts of mollusks for anatomical and microscopical use. This may be done in the following manner: Land and fresh-water gastropods may be killed by drowning, which can be done by putting them in an air-tight vessel filled completely with water so as to exclude all the air. By this means the soft parts will be more extended than if killed by boiling water, as recommended for cabinet specimens. They should then be gradually hardened as follows: Thirty per cent. alcohol, twenty-four hours; seventy per cent. alcohol, thirty hours, and eighty-five per cent. alcohol for final preservation. A one per cent. solution of chromic acid makes a good reagent, and the object, if not too large, may be left in it for twenty-four or thirty hours, after which they should be thoroughly washed in running water for twenty-four hours until the acid is removed.

It is of great importance that the radula or lingual ribbon should be preserved for study. This is a strap or belt of chitinous or horny matter, occupying the place in the mouth of the animal analogous to that occupied by the tongue in the vertebrates. The apparatus is protrusile and may be studied by feeding a snail, Limnæa stagnalis for example, soft crumbs of bread. In the larger forms it may be found with but little trouble, but the smaller forms must be boiled in caustic potash. This is accomplished as follows: Extract the animal from its shell and place in a test tube containing a tablespoonful of caustic potash which has become liquid by the attraction of atmospheric moisture. Hold the test tube at the side of the flame of an alcohol lamp until it boils, being careful not to let it boil over and that the animal matter is not thrown out of the liquid on to the dry side of the tube; if this happens dislodge it by shaking the liquid over it. Boil slowly until the animal matter is dissolved, then pour it out quickly into a watch crystal, refill the test tube with water and pour into another watch crystal. Give the first crystal a rotary motion, not too violent, so as to bring the solid particles to the center. Examine with a powerful hand lens; a sheet of white paper under the watch crystal will greatly aid in discovering the radula. This will be recognized by its curved, elongate shape and apparently reticulated surface. If the radula is not found in the first crystal, examine the second. When found, in either one of the two crystals, transfer to a glass slide and examine under the microscope with powers ranging from one inch to one-eighth inch. It had best be examined by transmitted light.

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*See Dall, l. c., p. 43.

After examining and sketching the form of the radula, it will be necessary to tear the ribbon up so as to get separate rows and individual teeth, since they lie over one another like shingles on a roof. The whole of one tooth cannot always be seen under one focus, because the recurved cusps of the teeth are higher than the base. When the teeth are very transparent it will be found necessary to stain the radula. To do this, first carefully clean the radula, then put it in a drop of strong solution of chromic acid; this stains it yellowish brown. It may then be mounted in glycerine jelly. Canada balsam is not a desirable medium, since it makes the object too transparent.

The teeth are disposed upon the radula in five principal longitudinal rows, which are easily distinguished. There is always one median longitudinal row of unpaired teeth, with several rows on either side. The central tooth is called the median or *rhachidian.* The teeth on either side are called laterals or *admedian,* and when there is an outer row of different teeth they are called marginals or *uncini.* In describing the teeth notes should be made of the form of the base of attachment, especially in the central tooth; also other special characteristics, such as simple, straight, curved or compound. Each tooth (as the central) may be made up of a number of projecting cusps, and great care should be used in describing and sketching these. In describing the radula, a dental formula is used to express the number and situation of the teeth and cusps; thus, if a radula has a single central, three lateral and twelve marginal teeth, and the first series has five cusps, the second series four and the third series one cusp, the formula would be expressed as follows:

$$\frac{12}{1} + \frac{3}{4} + \frac{1}{5} + \frac{3}{4} + \frac{12}{1}$$

The unit representing the tooth is written as a numerator and the number corresponding to the cusp as a denominator.*

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*For further information on this subject, the reader is referred to the paper of Dr. Dall spoken of above, from which the present information has been drawn.

VII. ECONOMY OF THE MOLLUSCA.

While the land and fresh-water species of the area are of no particular economic use to man, save as bait for fishing, yet in an indirect way they are of great benefit to him in furnishing food for birds and fish. Ducks and wading birds are particularly fond of such species as Bythinella nickliniana, Amnicola limosa, and other small univalves, not to speak of numerous small forms of Pisidia and Sphæria. Passerine birds are fond of Pupa, Vertigo and small Limaces. Fish eat mollusks as large as Campeloma decisum, and even extract the animal from Unios.*

Limax campestris is said to be eaten by the red salamander (Plethodon erythronotus, Green†) and it is probable that many animals, of whose food supply nothing is known, feed upon mollusks. It not infrequently happens that a too inquisitive animal gets caught in trying to obtain molluscan food, an instance of which passed before writer's notice some time ago. This was a western painted terrapin (Chrysemys marginatus) whose right hind foot had been caught and tightly held by a vigorous specimen of Unio luteolus. A similar case of a sora rail (Porzana carolina) has been noted, although the bird was probably not seeking the Unio for food.‡

There are many forms of mollusks (Pulmonata) which are hurtful to man by injuring his plants or gardens. Our greenhouses are infested with several European species, which have been introduced into the country by means of imported plants. These are Limax maximus, L. flavus and Vitrea cellaria. In the greenhouses they are sought after daily and killed by being placed in boiling water. It is probable that many of our larger species prey upon cultivated fields, although the writer has not heard of such being the case in the present area. A good way to keep them out of a cultivated patch is to spread a layer of dry ashes, some two feet in width, around the plot of ground. When the mollusk meets this obstruction it will secrete mucus so fast that it will soon die from exhaustion.

VIII. STATISTICS.

The following tables have been introduced to enable the reader to compare the molluscan fauna of this area with that of other areas. The total number of species and varieties is 153, distributed among twenty families and fifty genera. These may be primarily grouped as follows:

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*See The Nautilus, Vol. V., p. 128.

†Witmerstone, The Nautilus, Vol. III., p. 19.

‡The Nautilus, Vol. IX., p. 49.

1. Native species and varieties	147
2. Introduced species	6
Total number of species	153

1. SYSTEMATIC DISTRIBUTION.

GROUP.	Orders.	Families.	Genera.	Sp. & Var.
Gastropoda	3	18	38	103
Pelecypoda	2	2	12	50
Total	5	20	50	153

2. COMPARISON WITH THE UNITED STATES.

GROUP.	Chicago.	U. S.[*]
Families	20	35
Genera	50	98
Species	147	3000
Varieties	6	300

3. COMPARISON WITH MICHIGAN.

GROUP.	Chicago.	Michigan.[†]
Families	20	17
Genera	50	49
Species	147	246
Varieties	6	19

4. COMPARISON WITH PENNSYLVANIA.

GROUP.	Chicago.	Allegheny Co., Pa.[‡]	Philadelphia and Environs.[‖]
Families	20	15	19
Genera	50	30	40
Species	147	91	84
Varieties	6	2	3

[*] The numbers for the United States are only approximate, as there is no recognized catalogue of the mollusks of this region.

[†] "The Shell-bearing Mollusca of Michigan," by Bryant Walker, The Nautilus, Vol. VI., pp. 13, 31, 42, 63, 135. In all these tables, some species and varieties considered distinct by the authors are here considered synonyms, the better to compare with the present list.

[‡] "Land and Fresh-Water Shells of Allegheny County, Pa.," by S. H. Stupakoff. The Nautilus, Vol. VII., p. 135; Vol. VIII., p. 116.

[‖] "Mollusk Fauna of Philadelphia and Environs," by Morris Shuck. The Nautilus, Vol. VIII., p. 133.

5. COMPARISON OF GENERA.

In this table all the species of each genus found within the two limits are given.

GROUP.	Chicago.	Cincinnati, Ohio.*
1. Anodonta	3	3
2. Margaritana	10	13
3. Unio	24	67
4. Sphærium	9	8
5. Pisidium	4	1
6. Pleurocera	4	5
7. Goniobasis (Elimia)	2	3
8. Anculosa	....	2
9. Pomatiopsis	2	1
10. Somatogyrus	2	2
11. Amnicola	2	....
12. Cincinnatia	2	1
13. Campeloma (Melantho)	4	4
14. Vivipara	1	....
15. Lioplax	....	1
16. Valvata	2	1
17. Bythinella	1	....
18. Bythinia	1	....
19. Ancylus	3	2
20. Segmentina	1	1
21. Planorbis	7	5
22. Physa	2	2
23. Aplexa	1	....
24. Lymnæa	11	4
25. Carychium	2	1
26. Succinea	3	5
27. Vertigo	1	2
28. Pupa	9	7
29. Ferussacia (Cionella)	1	1
30. Punctum	1	1
31. Strobilops (Strobila)	1	1
32. Circinaria (Macrocyclis)	1	1
33. Vitrea (Hyalina)	4	4
34. Omphalina (Zonites)	1	3
35. Gastrodonta (Zonites)	4	7
36. Conulus (Hyalina)	1	1
37. Helicodiscus	1	1
38. Pyramidula (Patula)	3	4
39. Polygyra (Stenotrema, Mesodon, etc.)	14	18
40. Vallonia	3	2
41. Limax	3	3
42. Philomycus (Tebennophorus)	1	1
43. Testacella	1	0
Total	153	189

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*"Catalogue of Land and Fresh-Water Shells Found in the Vicinity of Cincinnati, Prepared for the Use of Beginners," by George W. Harper, A. M. Journal Cin. Soc. Nat. Hist., Vol. VIII., p. 89.

IX. ANATOMY OF THE SHELL.

For the benefit of those who may not be familiar with the different parts of the shell, but who may desire such a knowledge to aid them in understanding the relation of the terms used in this report to the objects, the following brief discussion of the external anatomy is presented:*

The pelecypods (or lamellibranchiates) are characterized (so far as the area under consideration is concerned) by procounced bilateral symmetry. Two mantle-lobes form the sides of the mollusk, and secrete the two flattened, subconical shells. These two mantle-lobes are prolonged into tubular siphons. The two valves are connected dorsally by a firm ligament, and the dorsal portion of the shell is specialized into teeth and sockets. Two large adductor muscles close the shell; these muscles are plainly indicated on the interior of the shell by the scars which they leave. The exterior of the shell is always covered with a thick epidermis.

In a specimen of Unio luteolus (Plate I.) we will notice the following characters: The anterior end (A) short and rounded, the posterior end (P) long and quadrate, the ventral margin (V) sharp, and the dorsal margin (D) rounded; the ligament (l), which holds the valves together; the lines of growth (lg), which mark resting stages in the growth of the shell; the lunule (lu), a portion of the hinge just above the teeth, and the umbo (u), (plural umbones), the nucleus (protoconch), or first part of the shell; this will be seen to be wrinkled and corrugated. The whole shell viewed from above (middle figure in plate) shows an elongated outline, with the ligament (l), lunule (lu), and umbones (u) in the center; the latter are frequently called the beaks.

On the interior of the shell we notice the following characters (lower figure): The long, external ligament which binds the valves tightly together, just above the lateral teeth (lt); this ligament acts as a spring to force the valves apart, the opposite from the muscles which pull them together. It is very brittle in the dried shell, but in the living animal is tough and firm. Beneath the ligament the two lateral teeth (lt) are seen, two long, ridge-like processes; in the right valve there is but one lateral tooth, which fits in between the two in the left valve. In front of these are placed the cardinal teeth (ct), two in number, which interlock with a single tooth in the right valve. These teeth are pyramidal in form. The lateral and cardinal teeth form the hinge, which with the ligament serve to guide the two shells in opening and closing. Above the cardinal teeth the umbo (u) is seen. At either end of the shell there is a scar which represents the basis of attachment of the anterior (a) and posterior (b) adductor muscles. A second smaller scar is seen posterior to the former, and is known as the anterior foot retractor muscle scar (c). Above the posterior adductor muscle scar there is a small scar which represents the attachment of the posterior foot retractor muscle (e). These scars are also known technically as cicatrices (singular cicatrix). In the cavity of the beaks are situated a number of small scars, the dorsal muscle scars, which represent the attachments of the small muscles which hold the umbonal and dorsal part of the animal to the shell; they are numerous and deeply impressed.

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*In preparing this topic the writer has made frequent use of Tryon's Structural and Systematic Conchology, Vol. I., to which he would acknowledge his indebtedness.

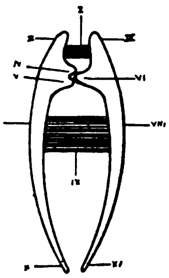

FIG. 2.

Diagram of a section of UNIO, showing method of opening and closing the valves. I., ligament; II., III., the umbones; IV., V., lateral teeth in the left valve; VI., lateral tooth in the right valve; VII., VIII., left and right valves of shell; IX., adductor muscle; X., XI., ventral surface of shell, or long arms of the lever. (After Lankester.)

As before remarked, the mantle or pallium secretes the shell substance (carbonate of lime); the edge of the pallium deposits new shell matter and adds to the size of the mollusk. It is firmly attached to the shell along a line which runs from the posterior to the anterior muscle scar, about half an inch from the ventral margin. This attachment is called the pallial line (pl) or pallial cicatrix.

The method of opening and closing the shell may best be represented by the accompanying diagram (Fig. 2, after Lankester) which is a transverse section of Unio, cutting through the ligament and adductor muscle. The two shells of a pelecypod form a double lever with the hinge teeth (IV., V., VI.) as a fulcrum. The ligament (I.) acts upon the short arms of the lever (the umbones, II., III.) as a spring, tending to keep the valves apart, or gaping. The adductor muscle acts upon the long arms of the lever (X., XI.) and by its contraction tends to keep the valves together. It will readily be seen that the mollusk is not at rest when the valves are tightly closed, for this requires some exertion on the part of the animal to pull them together and overcome the spring of the ligament. The period of rest is when the shells are slightly gaping.

The study of the structure of the shell is of great importance in understanding its formation and relation to the animal. If the shell of a Unio be broken so as to show a fractured edge, and studied with a powerful hand lens, the following structure will be seen (Fig. 3): An outer or epidermal layer, composed of almost black tissue (a); a layer of columnar tissue (b) set at right angles to the epidermal layer; and a prismatic layer (c) forming the inner surface of the shell, and composed of thin plates of membrane and carbonate of lime placed alternately. The function of the epidermis is to protect the more calcareous portion from erosion by the carbon dioxide (CO_2) in the water. The effect of this acid is seen on the umbones of the shells where the epidermis is thin or deficient. In most of the Unios the epidermis is green, olive green or black in color, and frequently rayed. It is formed by the cells on the edge of the mantle. Breaks which occur in the edges of the shell are easily supplied with the epidermal covering, but when they occur in the body of the shell, as at the upper third, no epidermal matter is deposited, but only nacreous matter, showing that it is the margin of the mantle which forms the epidermis.

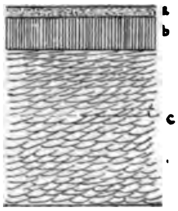

FIG. 3.

Diagram of a section of the shell of UNIO TUBERCULATUS, Barnes, showing the shell layers. a, epidermis; b, columnar layer; c, prismatic or inner layer. (Original.)

In the gastropods (univalves) or snails the shell is in but one piece and is in the form of a spiral, except in Ancylus and Limax. In a specimen of Polygyra albolabris the following characters will be noticed (Fig. 4): The evenly wound, closely coiled whorls; the small, light horn colored apex (a); the deeply impressed sutures (s); the large and swollen last whorl (lw); the wide aperture (ap); the white, reflected peristome (p) and the umbilicus (u) which is wide and deep in the young shell, but covered by the reflected peristome in the adult. The shell is also seen to be covered with rather coarse growth lines and also fine lines running parallel to the whorls. The parietal wall (pw) is covered with a spreading callus and has frequently a well-developed tooth or denticle upon it, situated near the upper part of the reflected peristome. In the gastropods, as in the pelecypods, the shell is a protection to the soft parts of the animal, which is attached to it only by the columella muscle. The structure of the shell substance is essentially the same as that described under the pelecypoda, except that the inner layer is not nacreous, and the outer layer, or epidermis, is not so heavy, except in some of the fresh-water forms.

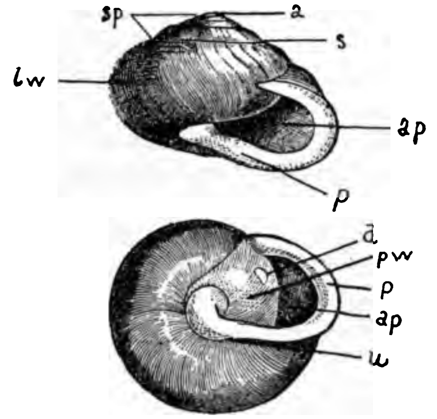

FIG. 4.

POLYGYRA ALBOLABRIS, showing parts of shell (after Binney, L and F-W, Sh; Figs. 227, 229). a, apex; ap, aperture; d, denticle; lw, last whorl; p, peristome; pw, parietal wall; s, suture; sp, spire; u, umbilicus.

As in the pelecypods, the shell is secreted by the mantle and conforms closely to the shape of that organ. The spiral shells are nearly mathematically correct, as much so as a living body can be. Most gastropods, excepting Pulmonata, are pro-

vided with an operculum which is situated on the posterior dorsal portion of the foot, and is secreted by a portion of the skin known as the opercular mantle. The operculum is horny in the fresh-water shells and is used to close the aperture of the shell when the animal withdraws. The shell is, with but few exceptions (Limax) external and capable of holding the entire animal within it. The epidermis in most fresh-water gastropods is thick and heavy and protects the shell from the erosive agency of the carbon dioxide. The effect of such erosion is seen in the truncation of the spire of such mollusks as Elimia, Pleurocera and Campeloma. Land mollusks are not so much affected by this gas. In Limnæa and other shells with long spires, the parts of the shell appear a trifle different, although the names applied are the same. These are sufficiently shown in the cut (Fig. 5) and need not be dwelt upon.

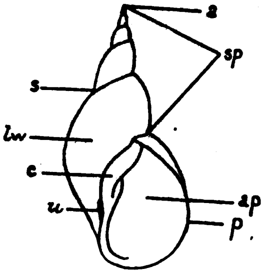

FIG. 5.

LIMNÆA, showing different parts of shell. a, apex; sp, spire; s, suture; ap, aperture; p, peristome; c, columella; lw, last whorl; u, umbilical region.

The external appearance of the animal presents the following characters (Fig. 6): The body is long and narrow and is differentiated into a head (h), tail, foot (f) and back, the latter covered with glandular tubercles arranged longitudinally. The head is connected with the body by a broad neck (n), and supports two eye-peduncles (ep), which bear at their extremities black, rounded eyes (e). Beneath the eye-peduncles are two short, blunt tentacles (t). The mouth is situated on the under side of the head in the middle line. The anal aperture is situated just abôve the mouth, a little to the right and a trifle to the rear.

The radula has now become such a factor in the study of the Mollusca that a knowledge of its characters is quite essential. As this organ is described for nearly all the gastropods cited in this report, a brief discussion of the several parts of the teeth is here presented.

The buccal-body is placed either at the end of a rostrum or in the body of the head; in the former it is nonretractile. The odontophore (or radula) is formed in the radula sac (Fig. 7, 18), where it is pushed forward as needed. Anteriorly the ventral portion of the pharynx forms a stout cartilage (5) which is provided with protractor (6) and retractor (7) muscles, by which the cartilage is moved backward and forward. The radula (2) rests upon this cartilage, being strongly fastened at the anterior end, and is brought down between the two fleshy lips (11, 12) and there exerts a backward and forward movement, rasping off with its sharp teeth particles of food as they are

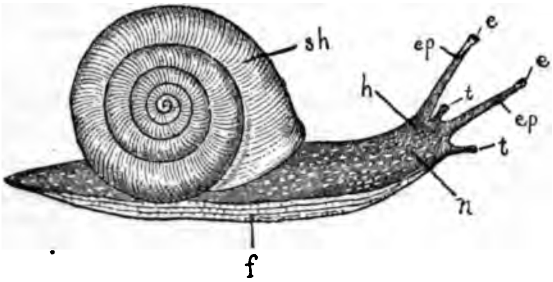

FIG. 6.

POLYGYRA ALBOLABRIS, showing parts of animal. (After Binney, L. and F-W, Sh., fig. 230.) e, eye; ep. eye-peduncles; f, foot; h, head; n, neck; sh, shell; t, tentacles.

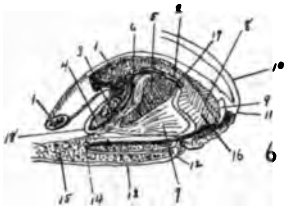

FIG. 7.

Buccal organs of HELIX (Guides for Science Teaching, Bost. Soc. Nat. Hist., VI., fig. 26). 1, œsophagus; 2, radula; 8, core of radula; 4, new teeth forming; 5, cartilaginous substance beneath the radula, serving for support and for the attachment of muscles; 6, posterior cartilage muscles; 7, anterior cartilage muscles; 8, cartilage bearing jaw; 9, jaw; 10, outer surface of mouth; 11, upper lip; 12, lower lip; 18, under surface of lip; 14, orifice of mucous glands; 15, mucous glands; 16, mouth; 17, cells lining under surface of radula; 18, radula sac.

pressed against the top of the mouth. The horny jaws serve to cut the food into small pieces for the radula to act upon. The chitinous radula is constantly growing forward from the core or diverticulum (3) in the same manner that the human finger nail grows upon its bed, and ceases to grow as the anterior end is reached. As fast as the front end wears out from use it is replaced by fresh material from the core. A layer of cells lines the under surface of the radula which carries the latter forward.

The radula is a belt of chitinous, transparent, yellowish or colorless material, and its upper surface is beset with a large number of siliceous teeth, arranged in parallel rows (Fig. 8).

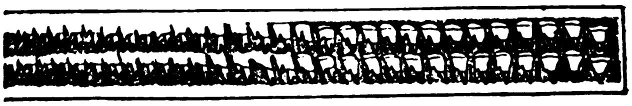

FIG. 8.

Two complete rows of teeth on the left side of a membrane of POLYGYRA TRIDENTATA Say (Binney & Bland, L. and F-W. Sh., fig. 220).

The portion of the radula nearest the mouth (anterior) is the most developed, and at the same time the most worn, while the posterior portion, or that part nearest the radula sac, is the least developed. The radula is usually divided into five longitudinal rows, each row differing from the one next to it. Thus we have a central row, on each side of this a lateral row, and on each side of this a marginal row (Fig. 9). Each tooth in each row is

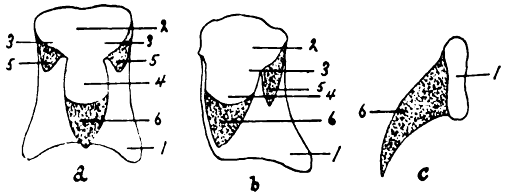

FIG. 9.

Diagram of teeth on the molluscan radula. a. median; b, lateral; c, uncinal or marginal. (Original.) 1., base of attachment to radula; 2., reflected portion; 3., side cusps; 4., median cusps; 5., cutting points of side cusps; 6., cutting point of median cusps.

made up of a number of different parts which, in their diversity, serve to distinguish the different groups of mollusks. Thus the central tooth has a strong, quadrate base of attachment (1) to the radular belt; the rest of the tooth is reflected (2) and provided with three cusps, a median (4) and two lateral (3), and each cusp has a cutting point (5, 6). The lateral and marginal teeth may be divided in the same manner into cusps and cutting points (b, c). The lingual teeth of all pulmonate mollusks are divisible into two types (1), the quadrate (a) and (2) the aculeate (c). The latter has no reflected portion, but a single thorn-shaped cutting point arises from its sole-shaped base of attachment (Fig. 9, c, 1, 6).*

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*Those who desire a detailed account of the anatomy of the Mollusca may consult the following works:

Bronn and Keferstein: Klassen und Ordnungen der Weichthiere.
Tryon: Structural and Systematic Conchology.
Lankester: Zoölogical Articles.
Fischer: Manual de Conchyliologie.

DESCRIPTION OF SPECIES.*

NOTE.—The writer has not been able to make a satisfactory key to the genera for the reason that a number are founded upon anatomical characters.

KEY TO FAMILIES IN THIS REPORT.

A. Shell bivalve.
  a. Shell large, pearly, lateral teeth placed posterior of cardinal teeth.......................................*Unionidæ*
  b. Shell small, not pearly, lateral teeth placed both anterior and posterior of cardinal teeth.......................*Sphæriidæ*
B. Shell univalve.
  a. Inhabiting land and breathing air; tentacles invertible and eyes at their tips.
    1. Shell heliciform, smooth, shining.
      *Shell flat, concave, smooth and shining, but not vitreous, umbilicus very wide and deep.......................................*Circinariidæ*
      **Shell flat to orbicular, smooth, shining and vitreous, umbilicus generally narrow........*Zonitidæ*
    2. Shell heliciform, dull, generally coarsely ribbed.
      *Edge of aperture simple, sharp...........*Endodontidæ*
      **Edge of aperture reflected..................*Helicidæ*
    3. Shells small, elongated aperture about one-third of length.
      *Aperture with teeth or folds†................*Pupidæ*
      **Aperture without teeth...................*Achatinidæ*
    4. Shell large, oval, aperture two-thirds of length..*Succineidæ*
    5. Animal without external shell.
      *Mantle covering only pulmonary cavity, shell internal.......................................*Limacidæ*
      **Mantle covering entire body, no shell.....*Philomycidæ*
    6. Animal with small, ear shaped shell placed at the posterior end of the body...............*Testacellidæ*
  b. Inhabiting land; tentacles contractile, but not invertible; eyes placed at their bases.
    1. Shell small columella with a fold, and parietal wall with one or two denticles..............*Auriculidæ*
  c. Inhabiting fresh water, but coming to the surface for air, which is necessary for respiration.
    1. Shell dextral; in one genus patelliform..........*Limnæidæ*
    2. Shell sinistral.................................*Physidæ*
  d. Inhabiting and breathing in fresh water; does not come to the surface for air.
    1. Shell large, spire very long and pointed; aperture about one-third of length.............*Pleuroceridæ*

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†Excepting *Pupa fallax*, which has no teeth.

2. Shell large, globose; spire short and obtuse; aperture and spire about equal in length..... *Viviparidæ*
3. Shell small, variable in form.
    1. Shell globose or elongated.............. *Amnicolidæ*
    2. Shell flat and discoidal.................... *Valvatidæ*

A. CLASS PELECYPODA.

"Aquatic, bilaterally symmetrical, acephalous mollusks, protected by a pair of shelly valves secreted by the lateral portions of the mantle, connected by a ligament, and moved by the contraction of muscles which connect the inner faces of the valves; feeding by ciliary action and destitute of a radula or jaw; breathing by lateral gills, the type of which is a midrib or stem, with a row of transversely oriented leaflets or filaments depending from each side of the stem, single, or mutually combined to form a direct or reflected plate; imperfectly sensible to light and rarely provided with peripheral visual organs; possessing olfactory organs (osphradia), auditory and equilibrating organs (otocysts), tactile papillæ and a nervous system composed of (usually three principal pairs of) ganglia united by nerves, but without a pedovisceral commissure; provided with an extensive tactile or locomotor organ (foot); a closed, though partly lacunary, circulatory system, containing (usually colorless) hæmolymph, and operated by a single or paired cardiac ventricle and two auri-

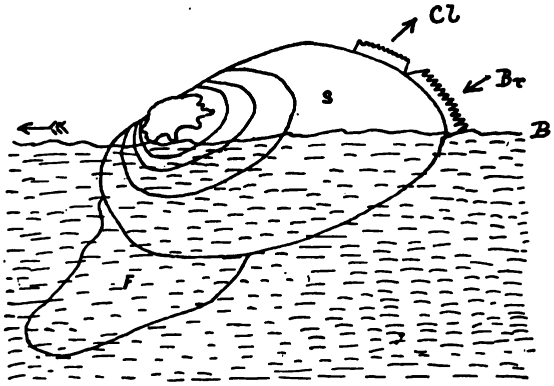

FIG. 9 A.

Diagram showing position of UNIO while ploughing its way through the bottom of a lake or river. (After Morse.) cl, cloacal siphon; br, branchial siphon; f, foot; s, shell; b, surface of mud at bottom. ⟵ direction in which the animal is moving. ⟶, currents of water to and from the gills.

cles; a more or less convoluted intestinal canal, with its oral and anal extremities at opposite ends of the body; a stomach; paired nephridia, connected with the pericardium, and discharging independently of the rectum; reproducing without copulation, by eggs and spermatozoa; monœcious or diœcious; development external to the ovary; the post-larval young protected by a prodissoconch, and sometimes exhibiting a nepionic stage; with a distribution in geological time from the Cambrian to the present day." (DALL.*)

Fig. 9A shows the position of a fresh-water pelecypod in life, while ploughing its way through sandy or muddy bottoms.

ORDER PRIONODESMACEA.

" Pelecypods having the lobes of the mantle generally separated, or, when caught together, with imperfectly developed siphons; the soft parts in general, diversely specialized for particular environments; the shell structure nacreous and prismatic, rarely porcellanous; the dorsal area amphidetic or obscure, rarely divided into lunule and escutcheon, and when so divided having an amphidetic ligament; ligament variable, rarely opisthodetic; armature of the hinge characterized by a repetition of similar teeth upon the hinge-line, or by amorphous schizodont dentition; habits active, sessile, or nestling, not burrowing; monœcious or diœcious." (DALL.*)

Superfamily Naiadacea.

"Shell of varied form, normally equivalve, inequilateral and dimyarian; rarely alate; shell substance nacreous and prismatic, with a conspicuous epidermis; area obscure or amphidetic; ligament parivincular, usually opisthodetic and external; ventricle embracing the rectum, with anterior and posterior aortas; gills reticulate, with direct and reflected laminæ, one or both pairs frequently utilized as a marsupium; pleural ganglia fused with the cerebral; otocyst impervious; pallial lobes usually free, except for an anal siphon; the pallial line simple; foot normally long, compressed, keeled, the byssus obsolete; anal end of rectum adherent; young usually with a distinct nepionic stage; station usually fluviatile." (DALL†.)

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*Trans. Wagner Free Institute of Science, Vol. III., Part 3, p. 511, 1895.

†Contr. to Tertiary Fauna of Florida, etc., Trans. Wagn. Free. Inst., Vol. III., Part 1, 1890

FAMILY UNIONIDÆ.

The author is greatly indebted to Mr. Charles T. Simpson, of the United States National Museum, Washington, D. C., who has revised the manuscript of this family and has made many valuable suggestions regarding the classification and anatomy of the species and genera of the region covered by this work. In some groups Mr. Simpson has not fully worked out the anatomy and synonymy. In those cases where Mr. Simpson has described a genus or section, or has added notes regarding the anatomy, his name has been placed in parenthesis after such description or note.

"Shell usually equivalve and inequilateral, smooth or variously sculptured, angular or rounded, symphynote or nonsymphynote, covered with a thick epidermis, which may be green, brown, yellowish, black, rayed, or variously painted; *beaks usually sculptured* with concentric ridges, corrugations, chevron shaped or radiacal patterns, or pustules, *often showing remains of the nuclear shell;* ligament opisthodetic, well developed, external except when the shell is symphynote. Interior nacreous; with or without hinge teeth, *but showing vestiges of them in every genus;* when present *always schizodont and arranged as cardinals, laterals* (pseudocardinals and pseudolaterals), *or both;* adductor scars generally distinct, the anterior commonly impressed; pallial line simple and generally well marked; *prismatic border usually narrow and not conspicuous.*

"Animal: *Labial palpi almost always wider than long, having the upper parts of the posterior margins united; anal opening usually separated from the superanal.* Mantle either free or closed posteriorly to form a branchial opening. *Embryo a glochidium,* the soft parts being inclosed in a pouch shaped bivalve shell, either with or without hooks, and borne in the inner or outer, or in all four leaves of the branchiæ, which are modified to form a marsupium."*

Of the 1,000 recent species of this family, over one-half inhabit the rivers and lakes of the United States. Like most fresh-water shells, the umbones of this group are nearly always eroded by the carbonic acid gas (CO_2) which is dissolved in the water. The Anodontas are generally found in still bodies of water, on muddy bottoms, while the Unios prefer, as a rule, the bed of running streams. The Mississippi Valley is the metropolis of this interesting family of mollusks, and it is here that they are found in their greatest development, beauty and variety. The present area, with its numerous lakes and streams, affords an excellent locality for this group and the species found are generally large and finely developed. The beautiful development of the shells is due, probably, to the abundance of lime in this region. Geologically the family dates back to the Triassic Period.

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* Simpson, Classification of Pearly Fresh-water Mussels, p. 318.

Pearls are frequently found in our fresh-water bivalves (Unio) and are caused by some irritating substance which becomes lodged between the mantle and shell. These pearls are similar in structure to the shell, consisting of three layers. The beautiful iridescence is due to light falling on the edges of transparent plates. The nucleus of the pearl may be any foreign substance, like a grain of sand, piece of food particle or parasitic worm. Spherical pearls are frequently found loose in the soft parts of pelecypods, particularly in the muscles. The pearls of our fresh-water shells are usually of but little value.

Parasites commonly infest the Unionidæ, and *Aspidogaster conchicola* is found in colonies in the pericardium of *Unio* and *Anodonta*. Another species, *Cotylaspis insignis*, is found in the upper branchial cavity of *Anodonta*. *Unio* may also be considered a scavenger, since it feeds on dead animal matter whenever it is within reach.

It is not generally known that in the North American *Unionidæ* the genital organs may be divided into three groups. The first group includes such species as *ligamentinus* Lam., *rectus* Lam., *alatus* Say, etc., in which the posterior part of the *outer branchiæ* are used as "branchial uteri." In this group the females are readily distinguished by the dilated postero-ventral surface, and the uteri are filled with embryones from late summer to the beginning of or even through the winter, and in the early summer the embryones are discharged. In the second group all four branchiæ are used throughout as branchial uteri, and there is no striking differences between the sexes. Examples of this group are *pustulosus* Lea, *æsopus* Green and *undulatus* Barnes. In this group, also, the uteri are free from embryones during the fall from about August, and probably all winter. During the early summer the branchiæ are filled with embryones and are discharged some time during July.

In a third group, which has plain oval to elongated shells, the embryos are found in the outer gill alone, filling the whole or the greater part of the length of it. In this division may be placed the true Unios, the Anodontas and some smaller groups. Besides these three great sections there are several smaller ones containing aberrant forms which are peculiar to North America.*

The embryo of Unio is called a glochidium (Fig. 10) and as the latter is frequently found in the gills of Anodonta and Unio, it may be well to briefly outline the characters of the larva, that it may be identified when seen. It is quite important to record the date upon which specimens are seen with embryos in the branchial uterus, and also whether the outer or all four gills are used as a marsupium.

The young of the Unionidæ develop to a certain stage called, as above, the glochidium. After fertilization the mantle and shell develop rapidly, but the digestive organs are not developed until six months or a year afterward. When the embryo, or glochidium, leaves the parent it has the form shown in Fig. 10. It is encased in an egg shell (e) in which are enveloped the two *shells* (ls, rs) united by a stout hinge which is so elastic that the two valves are frequently seen in the same plane. The ventral edge of the shell forms a toothed hook or hooks, which are movable and from which the larva receives its name. The valves of the shell are lined by large spherical cells from some of which large *setæ* (s) project into the mantle cavity. There is a stout *adductor muscle* (m) and the space between the two sides of the mantle is filled by a long, elastic, brown, coiled, thread-like *byssus* (b) which is formed in the tub-

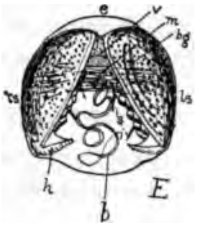

FIG. 10.

Anterior view of "Glochidium" of ANODONTA, enclosed in the eggshell, X100 (W. K. Brooks, Handbook of Inv. Zoöl., p. 330, fig. 174). b, byssus; bg, byssus organ; e, eggshell; h, hooks, ls, left valve of shell; m, posterior adductor muscle; rs, right valve of shell; s. setæ; v, velum.

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*For further information the reader is referred to the most interesting articles (to which the author is indebted for the notes used) by Dr. V. Sterki, in "The Nautilus," Vol. IX. No. 8, p. 91 (November, 1895), and by Mr. Chas. T. Simpson in "The Nautilus," Vol. XI. No. 2, p. 18, June, 1897.

ular *byssus organ* (bg) situated in the left side of the mantle between it and the shell.[*]

In this stage there are no auditory organs, gills or velum and the digestive cavity is a simple pouch with thick walls and a single large opening. The embryo of Anodonta reaches this stage in a few days after fertilization and remains in this stage without change until the following spring, when the parent discharges them through the cloacal siphon into the water. Here the embryos attach themselves by the byssus to the fins or gills of small fishes, close the valve of the shell onto the body of the fish by driving the hooks of the ventral surface of the valves into it. The fish covers the larva with a growth of epithelial cells and the embryo becomes encysted. Here it develops gills, œsophagus, stomach, intestine, renal organs and heart, and finally escapes from the cyst, falls to the bottom and completes its growth.[†]

* * *

Ovules filling the entire outer gill of the female; ovisacs not separated by a sulcus. (Simpson.)

GENUS ANODONTA (Bruguiére *Em*) Lamarck, 1799.

Shell: Generally thin, oval or oblong, inflated, without sculpture, anterior end evenly rounded, posterior dorsal region elevated or developed into a wing which meets the posterior end at a greater or less angle; epidermis generally smooth and nearly or quite destitute of rays; beaks concentrically sculptured; hinge line regularly curved, edentulous, *not incurved in front of the beaks*; nacre generally dull; muscle scars not impressed. (Simpson.)

Animal: Much like that of Unio, but the anal opening is always destitute of papillæ; outer gill of female when gravid enormously thickened and pad-like. (Simpson.)

Distribution: North America, Europe, Asia and North Africa, north of the Desert of Sahara.

KEY TO SPECIES OF ANODONTA.

A. Shell large.
  1. Breadth generally moderate, compared with length; color dark green or blackish, more or less distinctly rayed; umbonal sculpture very coarse........................*grandis*

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[*] The byssus is sometimes retained after the mollusk is well on its way to maturity and such an organ has been found in *Unio ligamentinus* Lam., eight inches in length, the shell being 27 mill. long. The mollusk was found attached to a stone by the byssus. See Sterki, The Nautilus. Vol. V., p. 73.

[†] See Brooks, pp. 330-332.

2. Breadth generally great, compared with length; color light green or brownish horn, not generally distinctly rayed; umbonal sculpture fine; attains but two-thirds the size of 1.................... ....*footiana*

B. Shell small.

1. Elliptical or cylindrical, umbones flush with the hinge line; color greenish, with faint rays; very thin and fragile...*imbecilis*

GROUP OF ANODONTA GRANDIS.

Shell large, inflated; umbonal region swollen beak; sculpture consisting of somewhat doubly-looped ridges which are often nodulous at the extremities of the loops. (Simpson.)

1. **Anodonta grandis** Say, pl. ii., pl. iii., fig. 1, pl. iv., fig. 1.

Anodonta grandis SAY, New Harmony Disseminator, Vol. II., No. 22, p. 341, 1829.

Anodonta plana LEA, Trans. Amer. Phil. Soc. 2d series, Vol. V., p. 48, pl. vii., fig. 18, 1834.

Anodonta declivis CONRAD, Amer. Journ. Sci. and Arts, 1st series, Vol. XXV., p. 341, pl, i., fig. 11, 1834.

Anodonta salmonia LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VI., p. 45, pl. xiv., fig. 41, 1836.

Anodonta decora LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VI., p. 64, pl. xx., fig. 63, 1836.

Anodonta gigantea LEA, Trans. Amer. Phil. Soc., 2d series. Vol. VI., p. 1, pl. i., fig. 1, 1838. (Variety, including the wide forms known as *plana*, *decora*, etc.)

Anodonta ovata LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VI., p. 2, pl. ii., fig. 2, 1838.

Anodonta harpethensis LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VIII., p. 224, pl. xix., fig. 42, 1840.

Anodonta inornata ANTHONY, American Journal of Conchology, Vol. II., p. 145, 1866. *Teste* LEA.*

Shell: When adult, rather solid; when young, thin and fragile; elliptical, more or less inflated, well rounded before and triangular behind, the point of the triangle rounded; dorsal margin straight in the young but slightly curved in the adult, ventral margin generally straight, but sometimes very much rounded, posterior margin forming an ellipse in the male and a ram shape in the female; surface strongly marked by growth lines, which become elevated ridges as the shell increases in age; umbones not much elevated (generally), of a greenish golden or bronze color in the young, but becoming dark brownish or greenish with age, frequently eroded, and marked by five

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*Some of the synonymy adopted for the Unionidæ is taken from Prof. Call's work on Arkansas Unionidæ in Trans. Acad. Sci., St. Louis, Vol. VII., No. 1, 1895.

strong, elevated, wavy wrinkles, which are arranged in two parallel rows, forming a double loop; ligament strong, dark horn color; epidermis variable in color, in the young it may be light greenish with faint indications of rays (sometimes stronger), while in the adult it is dark green, blackish or (rarely) reddish, with very faint diverging rays; umbonal slope rounded; hinge line slightly curved, a trifle thickened; adductor muscle scars and pallial line distinct but not impressed, iridescent; *protractor pedis* muscle scar distinct; dorsal muscle scars situated on the anterior face of the cavity of the beaks, deeply impressed and strongly striate; cavity of the beaks shallow, inflated; nacre silvery white in the young, but changing to purple in old specimens; iridescent.

Length,	**128.00;**	**height,**	**71.00;**	**breadth,**	**52.00**	**mill.**	**♂ (9297).***
"	**128.00;**	**"**	**74.00;**	**";**	**55.00**	**"**	**♂ (9528).**
"	**96.00;**	**"**	**48.00;**	**"**	**42.00**	**"**	**♂ (9528).**
"	**75.00;**	**"**	**48.00;**	**"**	**29.50**	**"**	**♂ (9842).**
"	**116.00;**	**"**	**67.00;**	**"**	**45.50**	**"**	**♀ (8419).**
"	**76.00;**	**"**	**46.00;**	**"**	**29.00**	**"**	**— (12417).**

Animal: **Generally pinkish white, sometimes yellowish, spotted with blackish dots about the abdomen; liver brown; gills yellowish white; tentacular portion of mantle dark brown**ish black; labial palpi yellowish brown, not large, tongue-shaped, united only for a short distance along the dorsal margin; gills (*ctenidia*) large, the outer one smaller than the inner, united above throughout their entire length, rounded anteriorly and posteriorly; adductor muscles large and powerful; mantle transparent, somewhat vitreous; branchial and cloacal siphons large, the former lined with numerous dark brownish black tentacles, the latter plain. The pericardium, containing the heart, is situated somewhat toward the posterior end, and the pulsations are somewhat peculiar in some of the specimens examined; there is first a short, quick pulsation, followed immediately by a long, slow pulsation; the writer counted thirteen short and thirteen long pulsations, twenty-six in all. In several other specimens fifteen regular pulsations were counted. The latter is probably normal.

A curious little parasite belonging to the genus *Diplodontus* (family Hydrachnidæ) infests the mantle cavity of this species.

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*In measuring the pelecypods in this report the distance from the anterior to the posterior is called length, that from umbones to ventral border, height, and the diameter between the valves at their widest part, breadth. This differs from Dr. Lea's method, he calling the present height the length.

As many as half a dozen individuals have been found in a single *Anodonta*. (9668.)

Distribution: Western New York, west to Arkansas; British America south to Texas.

Geological distribution: Pleistocene.

Habitat: In lakes and rivers where there is little or no current. Prefers a muddy bed.

Remarks: The above description is drawn from a collection of over a hundred specimens from various localities. It is a very variable species, particularly in its corpulency, but may be distinguished from all other species found in this region by its large size and general dark green or black color. The peculiar undulate character of the umbones will also distinguish it from related species. This mud loving species is frequently found buried in the mud to the depth of eight inches or more. The young are somewhat alate, but lose this character as they mature. The rays are very variable; sometimes in the young shell they are very strong, grass green in color over a yellowish green background, and again appearing very faint on a dark green background. The specimens found in the northern region show more diversity of form than do those from the southern and western regions. In the former region the variation is from long and narrow to short and stumpy, in this respect approaching *A. footiana*.

On October 26, 1897, while the south pond in Lincoln Park was being cleaned, a colony of this species was found which surpassed anything hitherto found in the area in size and perfection. The epidermis was bright grass green, with fine, darker rays; the umbonal region was of a purplish or pink color, which in some examples reached far down the shell. The lines of growth on the larger specimens were very coarse and wrinkled about the margins of the shell. The larger specimens measured as follows:

Length,	171.00;	height,	98.00;	breadth,	68.00	mill.
"	167.00;	"	100.00;	"	65.00	"
"	165.00;	"	96.00;	"	62.00	"
"	156.00;	"	95.00;	"	59.00	"
"	130.00;	"	75.00;	"	54.00	"
"	137.00;	"	71.00;	"	54.00	"
"	147.00;	"	89.00;	"	58.00	"
"	152.00;	"	78.00;	"	58.00	"

The specimens were found in a black, sticky mud, and were buried a foot beneath the surface.

A large number of specimens were dissected to ascertain if any tangible differences could be found in the shell between the sexes, but with a decided negative result. No differences could be found, excepting that the females were generally larger. A male and female of equal size gave the following measurements:

Length, 108.00; height, 67.00; width, 50.00 mill. ♂
" 108.00; " 65.00; " 48.00 " ♀

In all the females the outer branchium only was used as a marsupium and this was of a dark brown color, very much swollen and so heavy that the least touch caused it to rupture. The glochidia were fully developed and very active, and seemed ready to be discharged into the water.

2. **Anodonta footiana** Lea, pl. iii., figs. 2, 3, 4; pl. iv., fig. 2; pl. viii., fig. 5.

Anodonta footiana LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VIII., p. 225, pl. xx., fig. 44, 1848.

Anodonta marryattana LEA, l. c., Vol. VIII., p. 226, pl. xx., fig. 45, 1843.

Anodonta opalina ANTHONY, Amer. Journ. of Conch., Vol. I., p. 159, pl. xiv., fig. 2, 1865.

Anodonta subangulata ANTHONY, Amer. Journ. of Conch., Vol. I., p. 158, pl. xiii, fig. 1, 1865.

Anodonta McNeilii ANTHONY, Amer. Journ. of Conch., Vol. II., p. 144, pl. vi., fig. 1, 1866.

Shell: Thinner than *A. grandis*, much inflated, suboblong rounded before and triangular behind, the apex of the triangle truncated; dorsal margin straight; ventral margin straight or slightly rounded; posterior margin elliptical in the male and plough shaped in the female; surface marked with growth lines as in *grandis;* umbones not much elevated, light yellowish green in color, but generally eroded and pearly, and marked by four distinct, elevated, wavy wrinkles, arranged as in *grandis*, but very much finer; sometimes there is a fifth, very faint ridge; ligament strong, dark horn color; epidermis generally light greenish straw colored, varying to straw colored, horn or reddish, and generally without rays of any kind (sometimes very faintly rayed); umbonal slope very much rounded, owing to the greatly inflated umbonal region; hinge line very slightly curved, a trifle thickened; adductor muscle scars, *protractor pedis* muscle scar and pallial line distinct but not impressed; dorsal muscle scars as in *grandis*, small, slightly impressed; cavity of the beaks deep, inflated; nacre silvery white, iridescent, sometimes light mauve or salmon colored. In some specimens the hinge line and edge of valve are mauve while the interior is salmon colored.

Length,	100.00;	height,	63.00;	breadth,	55,00	mill.	♂ (7165).
"	99.00;	"	55.00;	"	41.00	"	♂ (9299).
"	87.00;	"	48.00;	"	31.50	"	♀ (1693).
"	51.00;	"	32.00;	"	21.50	"	— (9844) Juvenile.

Animal: Not differing essentially from *Anodonta grandis.*

Distribution: Northern part of the United States and Canada. A species of the St. Lawrence drainage, but sometimes found in the Mississippi drainage.

Geological distribution: Pleistocene.

Habitat: Similar to that of *A. grandis.*

Remarks: The present species is very closely related to *A. grandis* and would, perhaps, be more correctly placed as a variety of that species. I am much opposed to the idea of varieties in this family, from the fact that it is difficult to find constant characters within the species. It seems to me that when tangible characters are present the form should rank as a species. The specimens before me show the following distinctive characters: In *footiana* the umbonal region is *very* much inflated and the anterior and posterior angles are very sharp; in *grandis* the umbonal region is more flattened and the angles are more gentle; in *footiana* the umbones have four fine, distinct wrinkles while in *grandis* there are five coarse ones; *footiana* is generally light green or brownish horn in color, while *grandis* is generally dark green or black. *Footiana* belongs to the St. Lawrence drainage, while *grandis* belongs to the Mississippi drainage. The two species frequently overlap, however, and there are many forms which are difficult to place. *Grandis* is by far the most common of the two species in this region. The specimens from Berry Lake (No. 7165) are unusually corpulent, those found at Winnetka (Nos. 9298-9299) being more typical.

GROUP OF ANODONTA IMBECILIS.

Shell rather thin, smooth, shining; umbonal region usually flattened, often rayed with delicately waved fine lines. (Simpson.)

3. **Anodonta imbecilis** Say, pl. v., fig. 1.

Anodonta imbecilis SAY, New Harm. Diss., Vol. II., No. 23, p. 355, 1829.

Anodonta incerta LEA, Trans. Amer. Phil. Soc., Vol. V., p. 45, pl. vi., fig. 16, 1832.

Anodonta hordea GOULD, Proc. Bost. Soc., N. H. Vol. V., p. 229; 1855.

Shell: Very thin and fragile, more or less elliptical, somewhat inflated, broadly rounded before and triangular behind, where it is much produced; dorsal margin obsoletely straight, ventral margin slightly rounded; surface smooth and shining, lines of growth very faint, excepting on the alate portion of the postero-dorsal margin and at the posterior end; here and there there is a black line which marks a heavier growth line than usual; umbones perfectly flush with the hinge line, brownish horn in color and marked by several concentrically arranged ridges of small size; the umbones are placed pretty well toward the anterior end; posterior slope subexcavated, anterior slope rounded; ligament thin and weak, light brown in color; epidermis bright grass green, brownish horn about the umbones, with numerous darker green rays extending to the ventral margin; hinge line simple and thin; muscle scars and pallial line rather faint; beaks without cavity; nacre silvery white, very iridescent.

Length, 59.00; height, 29.00; breadth, 21.00 mill. (12454).
" 50.00; " 26.00; " 18.00 " (12454).
" 41.00; " 22.00; " 12.00 " (12454). (Young.)

Animal: Anal opening small, outer rather large, with many brown papillæ; branchiæ slightly curved below, nearly equal in size, free nearly the whole length of the abdominal sac, marsupium occupying the whole of the outer gill. (Simpson.)

Distribution: Western New York to Arkansas, Canada to Texas and Louisiana.

Geological distribution: Pleistocene.

Habitat: Found on a muddy bottom in creeks, small rivers and ponds.

Remarks: This is one of the most beautiful and one of the most distinct of all Anodontas. Its beautiful grass green, fragile shell, so delicately rayed, its umbones flush with the hinge line and its peculiar shape at once distinguish it from all other forms. The young are frequently somewhat alate and some specimens are lighter in color than others, and they may be rayed or rayless. The only locality at present known is at Willow Springs, on the Desplaines River, where it is said to be quite abundant.

GENUS **ALASMODONTA** Say, 1819.

Shell: Solid rhomboid with a posterior ridge more or less biangulate behind, with a smooth, hard, shining epidermis, which is usually rayed; beak sculpture consisting of a few coarse parallel ridges, which usually nearly follow the growth lines, but sometimes become somewhat double looped with fine radiating ridges behind the beaks and often in front of them; hinge teeth imperfect; one large, curved, compressed, irregular cardinal under the beak of the left valve which is often reflected upward, and a compressed, sometimes rudimentary tooth in front of it, the large tooth cutting off the hinge plate in the right valve; one cardinal in the right valve which falls between the two in the left valve; laterals blurred, generally having irregular ridges sloping back and downwardly on the hinge plate.

Animal: Much as in Unio; inner gill either wholly free from the abdominal sac or more or less united to it. Outer gill of female filled entirely with embryos when gravid; anal opening smooth or only slightly cornulate. (Simpson.)

KEY TO SPECIES OF ALASMODONTA.

A. Shell large.
  a. Shell compressed.
    1. Height nearly equal to length.................... *complanata*
    2. Height about half of length... .... *rugosa*
    3. Similar to 2, but lateral teeth well developed
      and umbonal sculpture finer.......... .... *pressa*
  b. Shell inflated.
    1. Breadth one-half of length .... *marginata*
B. Shell small, thick, quadrate................................. *deltoidea*

GROUP OF ALASMODONTA RUGOSA.

4. **Alasmodonta rugosa** Barnes, pl, viii., figs. 3, 4, pl. vii., figs. 1, 2.

Alasmodonta rugosa BARNES, Amer. Journ. Sci. and Arts, 1st series, Vol. VI., p. 278, pl. xiii., figs. 21a, 21b, 1823.

Shell: Elliptical, rather thick, not inflated (the female is a trifle inflated), rounded before and obtusely angulated behind; dorsal margin straight, ventral margin straight in the male and curved in the female; umbonal slopes almost flat in the male and slightly rounded in the female; surface marked by heavy growth lines which form strong wrinkles on the dorsal part of the posterior angle; umbones neither elevated nor inflated, light brown in color, frequently eroded, and marked by three strong, almost straight, elevated ridges, the apex directed anteriorly; ligament long and narrow, dark horn color; epidermis yellowish green, delicately rayed with dark green; cardinal teeth thick and heavy, more or less pyramidal, striated on the upper surfaces; lateral teeth rudimentary, being little more than a thickening of the hinge plate; anterior adductor muscle scar very wide, deeply impressed, slightly striate and iridescent, confluent; posterior adductor muscle scar wide, not much impressed, confluent, iridescent; *protractor pedis* muscle scar wider than long, not much impressed; dorsal muscle scars situated on the posterior face of the cardinal teeth, pit-like; pallial line slightly impressed in the anterior part of the shell; cavity of the beaks shallow; nacre silvery bluish white, iridescent, salmon tinted toward the beaks. In old specimens the interior of the valve is bordered by a wide band (6–8 mill.) of dark purple or violet.

Length, 104.00; height, 57.00; width, 27.00; mill. ♂ (9388).
" 110.00; " 62.00; " 38.00; " ♀ (9524).
" 162.00; " 81.00; " 46.00; " ♂ (coll. Jensen).

Animal: Generally flesh colored or salmon, inclining to yellowish brown in places, yellowish white on abdomen and black on tentacular part of siphons; ctenidia short and wide, the inner one the largest, rounded before and pointed behind, united to each other and to the opposite pair for their entire length, the outer filled throughout with embryos in the female; labial palpi not large, rounded—triangular, united and attached at base and partly above; siphons yellowish white inside, shading into brownish and jet black on the edge of the tentacular portion, the tentacles being short; foot thin, dark flesh color; liver brownish, tinged with yellow; mantle rather thin. Heart pulsations slow and regular—thirteen per minute.

Distribution: Southern Canada south to Texas and Alabama, New England west to Kansas.

Geological distribution: Pleistocene.

Habitat: About the same as *A. complanata.*

Remarks: A species at once distinguished by its rugose posterior margin. *A. pressa* Lea has a general resemblance, and is frequently confounded with the present species by many conchologists, but the character of the umbones will at once distinguish the two species. See remarks under *pressa*. *A. rugosa* seems to be an abundant shell and is a lover of muddy rivers, at least in this region. It is found in great variety of form and size in Thorn Creek and the Little Calumet River. Specimens from the former locality are very rugose.

GROUP OF ALASMODONTA PRESSA.

5. **Alasmodonta pressa** Lea, pl. vi., fig. 8; pl. x., fig. 4.
Unio pressus LEA, Proc. Amer. Phil. Soc., Vol. II., p. 237, 1843.
Symphynota compressa LEA, Trans. Amer. Phil. Soc., Vol. III., p. 450, pl. xii., fig. 22, 1830. (Preoccupied.)

Shell: Of good size, quadrangular, compressed, thin; rounded before and squarely truncated behind; dorsal margin straight, ventral margin slightly rounded; surface roughened by the lines of growth, which are more or less sharp and elevated on the borders; umbones small, very much depressed, compressed, reddish brown, marked by about six well developed, large, elevated, undulating ridges; anterior umbonal slope gently rounded, posterior slope rounded and slightly excavated; ligament short, wide, dark brown or black; epidermis reddish, corneous, yellowish or greenish, sometimes blackish, frequently covered with a deposit of foreign matter and rayed similar to *A rugosa;* cardinal teeth double in both valves; in the left valve there is an elevated, rounded tooth just below the apex of the umbo, then a smaller, long and narrow tooth in front of this; in the right valve there is a very large, long and narrow tooth anterior to the umbo, and a very small, long and narrow thickening of the hinge line above this; sometimes, in very old specimens, there is a third prominent tooth between the two just mentioned in each valve; the cardinals are peculiar in being long, narrow, elevated and thin; they are smooth, or only very slightly roughened at their apices; lateral teeth weak, long, thin, lamelliform, smooth; there is frequently an indication of a second lateral in the right valve; anterior adductor muscle scar longer than wide, impressed, smooth; posterior adductor muscle scar not very distinct, confluent, diameters equal; *protractor pedis* muscle scar wider than long; slightly impressed; dorsal muscle scars scarcely visible, situated on the posterior face of the cardinal tooth; pallial line distinct, crenulated, impressed anteriorly; cavity of the beaks very shallow; nacre pearly white, very iridescent, inclining in some specimens to flesh color.

Length, 85.00; height, 50.00; breadth, 26.00 mill. (12311).
" 68.00; " 39.00; " 18.00 " (12411).

Animal: Generally dirty white, black on tentacular portion and edge of mantle; ctenidia large, rounded before and obtusely pointed behind, generally short and wide, attached above as in *A. rugosa;* labial palpi small, subtriangular, united at base and partly above; siphons dirty white inside, blackish on the edge; branchial opening large with papillæ; cloacal opening small without papillæ; foot thin, dirty white in color; mantle thin, somewhat thickened on the border. The whole outer branchium is occupied as an uterus.

Distribution: New York to Iowa, Michigan to Kentucky.

Geological distribution: Pleistocene.

Habitat: In creeks, buried in black, slimy mud to the depth of five or six inches. In this area it is found only in creeks, never in rivers or ponds.

Remarks: This species strongly resembles *Alasmodonta rugosa* Barnes, and is taken for that species by very many conchologists. In *pressa* the posterior margin is seldom roughened and the lateral teeth are generally more developed than in *rugosa;* the purple band on the edge of the valve in *rugosa* is absent in *pressa.* The characters of the cardinal teeth are very peculiar, and will at once distinguish this species. Specimens from Hickory Creek, where the species is abundant, have a yellowish epidermis beautifully rayed with deep grass green, and the umbones are distinctly marked. Just beneath the cardinal teeth, and posterior to the anterior muscle scar, the shell is thickened by a heavy deposit of shelly matter.

GROUP OF ALASMODONTA COMPLANATA.

6. Alasmodonta complanata Barnes, pl. viii., figs. 1, 2; pl. ix., figs. 1, 2, 3, 4.

Alasmodonta complanata BARNES, Amer. Jour. Sci. & Arts, 1st ed., Vol. VI., p. 278, pl. xiii., figs. 17a, 17b, 1823 (preoccupied by *Unio complanatus* Solander).

Margaritana katherinæ LEA, Synop. Fam. Naid., 2d ed., 1839.

Shell: Very large and thick, heavy, subquadrate, alate, especially in the young; compressed in the male and inflated in the female; rounded before and triangulate behind; the angles straight; in the young shell this division is not so pronounced, the posterior border being broadly rounded; dorsal margin but slightly curved, ventral margin with a gentle curve in the male and a pronounced curve in the female; umbonal slopes almost flat in the male but strongly rounded in the female, the posterior slope a trifle excavated; surface marked by coarse lines of growth, which are generally raised into sharp ridges; umbones not elevated or inflated, light yellowish in color in the young, but changing into brown and black in old shells, and marked by four coarse, elevated ridges arranged in a double loop, the apex directed anteriorly; the umbones are frequently eroded; ligament very strong, long, narrow, dark brown or black in color; epidermis variable, yellowish brown marked by darker rays in the very young, changing to black or greenish, slightly rayed in the half grown forms, and deep reddish black or jet black in the adult, the red color predominating in the region of the umbones; in some specimens the alate portion of the postero-dorsal portion is strongly wrinkled; cardinal teeth very thick, elevated, compressed, longer than wide, striated, two in the left and one in the right valve; a single female examined had a second rudimentary cardinal in the right valve; the posterior cardinal in the left valve is wider, thicker and more elevated than the anterior cardinal; lateral teeth represented by elevated ridges; that in the right valve is very thick and long and fits into a depression in the left valve, the ridges on each side corresponding to the lateral teeth in typical *Unio;* posterior adductor muscle scar excavated, striated, confluent, very wide; anterior adductor muscle scar oval, wide, not so much impressed, confluent; *protractor pedis* muscle scar very wide, impressed, striate; dorsal muscle scars small, very deeply excavated, situated on the posterior face of cardinal teeth; pallial line not much impressed; cavity of the beaks shallow; nacre silvery white with a bluish tinge, iridescent; in some specimens the whole shell inside of the pallial line is a deep salmon color.

Length,	135.00;	height,	96. 00;	breadth,	39.00	mill.	♂ (9692).
"	150.00;	"	112.00;	"	48.00	"	♀ (From Milwaukee, Wis.)
"	108.00;	"	79.00;	"	28.00	"	♂ (9691).
"	45.00;	"	40.00;	"	12.00	"	juvenile (10086).
"	177.00;	"	132.00;	"	30.00	"	♂ (13438).
"	111.00;	"	76 00;	"	53.00	"	♀ (coll. Jensen).
"	120.00;	"	94.00;	"	33.00	"	♂ (13084).

Animal: Generally dark flesh color or salmon; ctenidia long and narrow, outer crowded throughout with ova in the female, half-moon shaped, rounded at both ends, scalloped on the ventral border, chocolate brown in color, united above and to the opposite pair for their entire length; labial palpi rather long, tongue shaped, color similar to the gills, united at base; foot large, thin, rich salmon color; the abdomen pale salmon or flesh color; siphons yellowish white inside, the tentacular portion brownish black; mantle whitish, edged with black or brownish; liver and cardiac pouch brownish.

Distribution: Mississippi and Ohio drainages; Great Lakes.

Geological distribution: Pleistocene.

Habitat: Found on a muddy bottom, generally in rivers, in water from knee to fifteen feet in depth.

Remarks: This is a very characteristic species, found generally in the larger rivers. It is at once distinguished from

all species by its squarish, heavy shell and peculiar, double looped umbonal sculpture, this last character being peculiar to the species. The female may be known by its more swollen shell, which is very much rounded on the ventral border. The very young shell (museum number 10086) shows the characteristic marking of the umbones better than the adult form. (Plate ix., fig. 4.) Pearls are frequently found in these species.

A single female specimen, from the Little Calumet River, was examined April 6, 1897. This specimen was very broad and extremely alate. In this specimen the entire outer gills were used as brood pouches, and the glocidia were very numerous and active, closing their delicate shells frequently with a sudden jerk. They measured .30 mill. in length, and the byssus, adductor muscle and hooks on the valves were very much developed and conspicuous. There is a great difference between the male and female shells, so much so that they might easily be mistaken for different species. The Little Calumet River is the metropolis of this form, where it is largely and finely developed.

GROUP OF ALASMODONTA MARGINATA.

7. **Alasmodonta marginata** Say, pl. iv., fig. 4; pl. vii., fig. 7; pl. xxii., fig. 8. *Anadonta marginata* SAY, Nich., Encycl., ed. 1, Vol. II, pl. iii, fig. 5. 1816.

Shell: Smooth or slightly wrinkled, inflated, more or less quadrangular, rounded before and triangular behind, the apex truncated and placed near the ventral margin; dorsal margin curved, ventral margin straight or curved *inward*; umbonal slopes broadly rounded, the anterior angle short and the posterior angle long, wide and almost flat; surface marked by lines of growth which are raised in various places, especially on the posterior angle; umbones large, a trifle elevated, inflated, dark brown in color and marked by three very coarse, undulating, elevated ridges, and a single feeble one, each ridge forming two slightly curved loops, all directed anteriorly; ligament wide, not very long, very dark horn color; epidermis brownish or greenish, with wide darker rays, extending from the umbones to the ventral border, and dotted with black spots and dashes in various places; the rays are not so conspicuous in old specimens as in young ones; cardinal teeth not heavy, thin, elevated, striated, one in the right and two in the left valve; lateral teeth represented by a thickening of the hinge plate; anterior adductor muscle scar long, rather wide, deeply impressed, marked by lines of growth; posterior adductor muscle scar wide and spreading, not much impressed; *protractor pedis* muscle scar not heavily impressed, marked by lines of growth, wider than long, and connecting with the anterior adductor muscle scar without a break; dorsal muscle scars situated on the anterior face of the cardinal teeth and in the cavity of the beaks, large and deeply pitted; pallial line impressed; cavity of the beaks shallow; nacre bluish white, pearly, and iridescent on the edges of the valves.

Length, 75.00; height, 42.00; width, 34.00 mill. (7159).
" 61.00; " 37.00; " 25.00 " (7160).
" 54.00; " 28.00; " 20.00 " (7161).

Animal: Anal opening rather large, without papillæ; branchial opening very small, with delicate brown papillæ; palpi not united at posterior edges; branchiæ large, curved below, inner much larger, united to abdominal sac all the way or partly free. Outer gill of female occupied throughout with embryos. (Simpson.)

Distribution: Western New York west to Iowa, Michigan south to Louisiana.

Geological distribution: Pleistocene.

Habitat: In rivers and lakes, on a muddy bottom, in from two to fifteen or twenty feet of water.

Remarks: A species at once distinguished by its heavy, inflated shell and peculiarly marked unbones, the latter being larger in proportion to the size of the shell than in any species found in the region. In *marginata* the lower posterior angle is directed downward, or only very slightly turned up, and the whole posterior region appears truncated. The rays are sometimes very wide, dark green over a yellowish green background, and without the black spots. Apparently confined to the southern and western regions.

8. **Alasmodonta deltoidea** Lea, pl. vi., fig. 2; pl. vii., fig. 4.

Margaritana deltoidea LEA, Trans. Amer. Phil. Soc., 2 series, Vol. VI., p. 43, pl. xiii., fig. 38, 1836.

Margaritana calceola LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VI., pp. 135, 143, 148, 1838.

Shell: Rather thick, not inflated, quadrate, compressed on the sides, rounded before and obtusely angular behind; dorsal and ventral margins straight; surface roughened by lines of growth, which are raised into ridges on the ventral portion of the shell; umbones a little elevated, prominent, brownish in color and marked by four coarse, elevated ridges, the apex directed anteriorly; ligament short, narrow, very dark brown or chestnut in color; epidermis brownish, with numerous dark green rays of variable width extending from the beaks to the ventral border; cardinal teeth small, elevated, thick, striated, that in the right valve large, thick, longer than wide, that in the left valve smaller, narrow, saddle shaped; lateral teeth represented by a thickening of the hinge line; anterior adductor muscle scar long and narrow, deeply impressed, striated; posterior adductor muscle scar almost as wide as long, scarcely impressed, confluent; *protractor pedis* muscle scar small, long and narrow, impressed; dorsal muscle scars situated on the posterior face of the cardinal teeth, large, deeply impressed; pallial line distinct; cavity of the beaks shallow; nacre bluish, tinged with salmon or pinkish on the anterior portion, iridescent.

Length, 41.00; height, 23.50; breadth, 15.50 mill. (10085).
" 38.00; " 23.00; " 15.00 " (10085).
" . 30.00; " 18.00; " 12.50 " (10092)
" 27.00; " 16.50. " 11.50 " (8364).

Animal: Yellowish white on foot, flesh colored on abdomen; mantle yellowish white edged with black; liver dark brown; ctenidia of medium size, rounded and united above for their entire length; labial palpi rather long, rounded, tongue shaped, narrow, flesh colored; siphons rather large, edged with black.

Distribution: Great Lakes and Mississippi Valley.

Geological distribution: . Pleistocene.

Habitat: Found associated with *U. marginata.*

Remarks: After an examination of numerous specimens I am led to place *calceola* in the synonymy of *deltoidea.* They occupy the same localities and have the same general shape, and the description of one will answer as well for the other. In the female the shell is more produced posteriorly and also a little wider; there is a decided ridge where the umbonal slope meets the sides of the shell. This is a common little mollusk and one which is easily distinguished by its small size, solid shells and bright green rays. The umbonal markings are large and well developed. Old specimens become very solid, and the epidermis changes to almost black.

KEY TO THE SPECIES OF UNIO.*

I. Shell generally thin, cardinal teeth but slightly developed, hinge line slightly thickened.
  a. Shell large, 45 mill. or more in length.
    1. Umbones large and coarsely wrinkled.
      †Ground color of shell yellowish horn with dark green rays sometimes uniform dark brownish or blackish; posterior end broadly rounded, almost truncated.........*edentulus*
      ††Ground color of shell greenish straw or light green with light green rays; posterior end acutely rounded. Umbones not so coarsely wrinkled as †..... ....*pavonius*
    2. Umbones small and finely wrinkled.
      †Color light green or blackish horn, shell elliptical, posterior end broadly rounded .... *ferussacianus*
      ††Color yellowish horn, shell subcylindrical, posterior end acutely pointed...........*subcylindraceus*
  b. Shell small, long and narrow, 35 mill. in length.......*hildrethianus*

II. Shell generally solid, cardinal teeth well developed and hinge line with well developed lateral teeth.

A. Shell smooth, with distinct rays.
    1. Length 2½ times height.
  a. Epidermis yellowish, plain or distinctly rayed with bright green, nacre white or pinkish................*anodontoides*
  b. Epidermis very dark green or black, rays faint, nacre rich purple...*rectus*
    2. Length about twice height.
  a. Shell large, inflated laterally, cylindrical, rays very narrow...*luteolus*
  b. Shell smaller and more pointed posteriorly than a; rays wide; shell much compressed.
      †Rays interrupted forming square spots ....*iris*
      ††Rays not interrupted, continuous; larger and more solid than †......................*spatulatus*
    3. Length one-third greater than height.
  a. Shell alate.
      †Shell rather thin, lateral and cardinal teeth thin and weak; color light yellowish with fine green rays..............................*gracilis*
      ††Shell solid, lateral and cardinal teeth solid; color dark green or black with fine rays.........*alatus*
  b. Shell not alate, rays in straight lines.
      †Shell inflated.
        *Shell large, rays wide and few in number....*ventricosus*

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*For the purpose of simplifying the work of determining the species of Unio, Strophitus, Anodontoides, Quadrula, Obliquaria, Plagiola and Lampsilis, the author has made a single key to contain all the species of these genera, thus doing away with the confusion which would follow the splitting up and placing of the key among these newly-recognized groups.

**Shell small, rays narrow and very numerous ....*multiradiatus*
††Shell compressed, rays wide with numerous finer ones between.......................*ligamentinus*
c. Shell not alate, rays made up of zigzag dashes.
†Shell elliptical, posterior end very pointed and with a slight shoulder................*donaciformis*
††Shell trigonal, posterior end not so pointed as †, and with a decided shoulder and also a heavy, elevated ridge, extending from the umbones to the ventral margin................*elegans*
B. Shell smooth without rays.
a. Shell large, long and narrow, laterally compressed.........*gibbosus*
b. Shell large, more or less quadrate, short and high, umbones depressed.
1. Shell almost quadrate, generally compressed, hinge teeth rather light, and cardinal teeth widely diverging...................................*rubiginosus*
2. Shell roundly elliptical, produced at the posterior end, hinge teeth solid and heavy, and cardinal teeth placed near together............................*coccineus*
c. Shell large, trigonal, umbones very much elevated and inflated....... ....*trigonus*
d. Shell very small, elliptical, thin ....*parvus*
C. Shell large, surface coarsely wrinkled.
a. Umbones much elevated and inflated, posterior end truncated, shell inflated...................................*plicatus*
b. Umbones depressed, not inflated, posterior end triangular, shell compressed................................ *undulatus*
D. Shell pustulose.
a. Pustules few and in the form of nodules........... ....*reflexus*
b. Pustules numerous.
1. Shell compressed, orbicular, ventral border rounded, pustules scattered over the surface..*verrucosus*
2. Shell compressed, quadrate, ventral border excavated, pustules arranged in two series on either side of a depressed bare spot..........*lacrymosus*
3. Shell inflated, orbicular, pustules scattered over the shell with no regard to system; pustules present or absent ....*pustulosus*

GENUS STROPHITUS Rafinesque, 1820.

Shell: Inflated, rounded, rhomboid, rather thin, with a hard, shining, often rayed epidermis; beak sculpture consisting of a few coarse subparallel ridges, which bend slightly upward posteriorly and are heaviest at the posterior angle of the shell with fine radiating lines in front of and behind these ridges; hinge line bent inward in front of the beaks; teeth rudimentary, usually consisting of an irregular compressed ridge, which is often reflected upward beneath the beak of the left valve, and one or two faint ridges in front of it on the right valve; laterals generally wanting.

Animal: Anal opening minutely papillose or crenulated; inner gill wholly or in part united to the abdominal sac; outer gill of the female filled when gravid with ovisacs *which run crosswise with it* and which probably empty through the outer wall of the gill. (Simpson.)

9. **Strophitus edentulus** Say, pl. xii., figs. 3, 5, 6; pl. xvii., fig. 3.

Alasmodonta edentula Say, New Harmony Disseminator, Vol. II., No. 22, p. 340, 1829.

Anodonta tetragona Lea, Trans. Amer. Phil. Soc., 2d series, Vol. X., p. 82, pl. viii., fig. 25, 1845.

Anodonta shafferiana Lea, Trans. Amer. Phil. Soc., 2d series, Vol. X., p. 288, pl. xxvi., fig. 56, 1852.

Anodonta arkansasensis Lea, Trans. Amer. Phil. Soc., 2d series, Vol. X., p. 273, pl. xxix., fig. 56, 1852.

Alasmodonta rhombica Anthony, Amer. Journ. of Conch., Vol. I., p. 158, 1865.

Anodonta annulata Sowb, Reeve, Conch, Icon., Vol. xvii., *Anodon*, pl. xviii., fig. 67, 1869.

Shell: Rather solid, not much inflated, long-ovate or elliptical in form, rounded before and obtusely angled behind, dosal margin slightly curved, ventral margin rounded; posterior margin obtusely rounded and posterior slope sometimes angulated; surface marked by strong lines of growth; umbones not much elevated, yellowish brown in color, eroded in adult specimens, and marked by three very large and coarse ridges, and one or two less conspicuous ones; the apex of the umbo is directed anteriorly; ligament strong, dark brown in color; epidermis light horn or yellowish brown with wide rays of dark green on the lighter background; the rays disappear in old specimens which become almost black; hinge line near the umbones reinforced by a tooth-like deposit which is a rudimentary cardinal tooth; adductor muscle scars, pallial line and *protractor pedis* muscle scar distinct but not impressed; dorsal muscle scars situated on the anterior face of the cavity of the beaks, the latter of medium depth; nacre bluish white, the cavity of the beaks and center of the shell, in some specimens, being strongly tinged with salmon; more or less iridescent.

Length, 68.00; height, 43.00; breadth, 26.00 mill. (8052).
" 48.00; " 28.00; " 19.00 " (9301).
" 76.00; " 44 00; " 29.00 " (coll. Jensen).
" 84.00; " 45.00; " 29.00 " (12413).

Animal: Generally brownish or yellowish brown in color, the mantle spotted with dark brown; ctenidia wide, not long, broadly rounded before and behind, united above and to the opposite pair throughout their entire length, brownish white in color; labial palpi of the usual shape, large, coarsely laminated inside, attached at base, dark yellowish brown in color on the inside, and light yellowish on the outside; foot large, dark flesh color shading into whitish on the abdomen; siphons yellowish white inside, changing to brownish and finally to black on the edge of the tentacular portion; anal opening minutely papillose; branchial with large papillæ; between the beaks and the pericardium the animal is pinkish. Heart pulsations regular, numbering ten to eleven per minute. The heart was seen beating for nearly half an hour after the animal was removed from the shell. The outer gill of the female is used as a marsupium and is filled with "ovisacs which run crosswise with the gill."

Distribution: Southern Canada, northern and central portions of the United States.

Geological distribution: Pleistocene.

Habitat: Found in the larger lakes and rivers, on a muddy bottom, in water from two to fifteen or more feet in depth.

Remarks: A widely distributed species, at once distinguished by the semidentate margin and coarse umbonal sculpture. When the interior is tinged with salmon it is one of our most beautiful shells. Some forms have the umbones a trifle elevated, and when in this state they greatly resemble some forms of *pavonius* (see remarks under that species). The rays are very variable and may be very distinct or hardly visible, and there is also considerable variability in width.

10. **Strophitus pavonius** Lea, pl. iii., fig. 5; pl. v., fig. 3.

Anodonta pavonia Lea, Trans. Amer. Phil. Soc., 2d series, Vol. VI., p. 78, pl. xxi., fig. 65, 1839.

Anodonta wardiana Lea, Trans. Amer. Phil. Soc., 2d series, Vol. VI., p. 46, pl. xiv., fig. 42, 1839.

Shell: Somewhat solid, a little inflated, elliptical, rounded before and acutely rounded behind; dorsal margin almost straight, ventral margin slightly rounded; surface smooth, marked by fine lines of growth; umbones elevated, inflated, light straw colored, marked by three strong elevated undulations, the apex directed anteriorly; ligament rather strong, dark horn-color; epidermis yellowish green, with light green rays extending from the umbones to the ventral margin; hinge line thickened with a distinct cardinal tooth in each valve, anterior to the apex of the umbo; muscle scars and pallial line distinct but not impressed; dorsal muscle scars situated on the anterior face of the cavity of the beaks, deep and very distinct; cavity of the beaks rather deep; nacre bluish white, iridescent; in old specimens the interior of the shell is tinged with salmon.

Length, 69.00; height, 37.00; breadth, 28.00 mill. (coll. Jensen).
" 49.00; " 28.00; " 20.00 " (12946).

Animal: Not differing essentially from *S. edentulus.*

Distribution: Mississippi and Ohio valleys; Great Lakes.

Geological distribution: Pleistocene.

Habitat: Similar to that of S. *edentulus.*

Remarks: This species may be distinguished from *edentulus* (which it greatly resembles, and of which it may be but a color variety) by the following points: The umbones are more inflated, and are situated nearer the center of the shell; the sculpture of the beaks is finer and less conspicuous; the ground color of the shell is greenish and the posterior end is acutely rounded. The cardinal tooth is also much more developed. In the young, the rays sometimes form broad bands of green. It is not at all impossible for the species to ultimately become a synonym of *S. edentulus,* as it is quite difficult to distinguish some forms of the two species. *Pavonius* is not common in the area under discussion.

GENUS **UNIO** Relzius, 1788.

Shell: Oval to elongated, rather solid, generally having a more or less developed posterior ridge and becoming arcuate with age; epidermis mostly dull colored and soft, rarely rayed; beak sculpture consisting of a few coarse ridges, nearly parallel with the growth lines, sometimes a tendency toward being double looped or to break into nodules. Cardinals (pseudocardinals), two in the left valve and one (sometimes a small second tooth) in the right valve, laterals, two in the left and one (sometimes a small second tooth) in the right valve, laterals sometimes blurred or undeveloped, cavity of the beaks shallow.

Animal: Much like that of *Anodonta,* but generally having papillæ more or less developed on the anal opening. Embryos filling the entire outer gill of the female and forming a smooth, even pad, not so swollen as in *Anodonta.*

GROUP OF UNIO GIBBOSUS.

11. **Unio gibbosus** Barnes, pl. xiv., figs. 3, 4; pl. xv., figs. 1, 2, 3. 4.

Unio gibbosus Barnes, Am. Journ. Sci. and Arts, 1st series, Vol. VI., pl. xi., fig. 12, 1828.

Unio arctior Lea, Trans. Am. Phil. Soc., Vol. VI., p. 10, pl. iv., fig. 10, 1834.

Unio dilatatus Rafinesque, Conrad in monograph, pl. xxi., 1838.

Shell: Of medium size, elongately elliptical, thick and heavy, compressed, rounded before and obtusely pointed behind; dorsal and ventral margins slightly curved or rounded; surface decidedly roughened by growth lines; umbones not elevated, compressed, yellowish brown, marked by five or six large wavy ridges; the umbones are directed anteriorly; anterior umbonal slope rounded; posterior slope rather flat, forming an angle with the sides of the shell; ligament long, rather wide, stout, dark horn or black; epidermis brownish or blackish, plain, sometimes reddish, and showing very light traces of rays; cardinal teeth small, double in both valves; the anterior tooth in the right valve very small, the posterior tooth elevated, triangular, thick, serrated, in the left valve equal, elevated, pyramidal, striated; lateral teeth long, lamellar, thick, serrated, sometimes tending to become double in the right valve; anterior adductor muscle scar large, deeply impressed, very strongly striated; posterior adductor muscle scar longer than wide, rather lightly impressed, concentrically striated; *protractor pedis* muscle scar wider than long, deeply impressed, striated; dorsal muscle scars situated below the hinge line posterior to the cardinal teeth, deeply impressed; pallial line impressed on the anterior part of the shell, crenulate; cavity of the beaks very shallow; nacre silvery white, salmon or purple, the purple being frequently confined to the center of the shell, below the hinge.

Length, 82.00; height, 36.00; breadth, 20.00 mill. ♂ (8423).
" 66.00; " 34.00; " 20.00 " ♀ (7388).
" 73.00; " 33.00; " 19.00 " ♂ (10087).
" 85.00; " 35.50; " 19.00 " ♂ (12412).

Animal: Yellowish brown in color, shading into creamy white; near the anterior part, the mantle edged with black, especially about the siphonal portion; anal opening of medium size with small papillæ; branchial opening larger with good sized papillæ; ctenidia long, rather wide, ends rounded, united above throughout their entire length, the outer ctenidium the smaller; labial palpi small, triangular, united at base, and for nearly the whole length of the posterior margin; liver dark brown. Pulsations of the heart regular, twenty per minute. Another animal examined had but fourteen heart pulsations.

Distribution: Western New York to Minnesota and Kansas; south to Texas and east to Georgia. (Call.)

Geological distribution: Pleistocene.

Habitat: In muddy rivers, in from ten to fifteen feet of water.

Remarks: A common and widely distributed species, recognized by its dull brown shell. It varies greatly in its length, some specimens being short and stumpy, and others long and narrow, in this form much resembling *Lampsilis rectus.* The umbonal sculpture is very pronounced, and helps not a little to distinguish the species. In some specimens there are faint indications of dark rays, but the typical form is entirely rayless. The nacre varies from pinkish white to very deep purple, and in this state very much resembles *Lampsilis rectus.* It is widely distributed, being found in the northern, western and southern regions.

GROUP OF UNIO HILDRETHIANUS.

12. **Unio hildrethianus** Lea*, pl. v., fig. 4.

Margaritana hildrethiana Lea, Journ. Acad. Nat. Sci., Phil., Vol. IV., p. 49.

Shell: Small, long, compressed, thin, rounded before and broadly rounded behind; dorsal and ventral margins straight; surface smooth, the growth lines distinct and considerably elevated on the anterior parts; umbones small, prominent but not much elevated, dark brown in color and marked by three or four elevated wrinkles arranged in a double loop; ligament rather short and narrow, light horn color; epidermis yellowish, greenish or brownish, sometimes streaked with reddish brown, perfectly plain; cardinal teeth very small, thick, depressed; lateral teeth barely indicated by a thickening of the hinge line; muscle scars very broad, scarcely impressed, lightly striated; dorsal muscle scars very small, deep; pallial line a trifle impressed; cavity of the beaks very shallow; nacre bluish with a white patch on the anterior part, iridescent. There is a peculiar "bulge" extending from the umbones diagonally to the postero-ventral border.

Length, 41.50; height, 19.50; breadth, 12.50 mill. (12949). ♀
" 38.00; " 18.00; " 11.00 " (12949). ♂

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*Mr. Simpson states that the generic position of this species is doubtful, and that it may take generic rank by itself; Mr. Simpson has been unable, as has also the author, to find specimens in a perfectly gravid condition.

Animal: Anal opening small, black, without papillæ; branchial opening rather large with crowded papillæ; mantle border decidedly thickened; inner gill larger in front, free from the abdominal sac a short distance posteriorly; gills not united to each other to the posterior extremity, but joined to the mantle to their posterior end. Outer gill contained a few ova in the specimens examined. (Simpson.)

Distribution: Great Lakes and Mississippi Valley.

Geological distribution: Pleistocene.

Habitat: In rivers and creeks, under stones and other objects. It is also found in mud which is free from débris.

Remarks: A small and characteristic species which is at once distinguished from all other species found in this region by its fragile shell, delicate hinge armature and minute beak sculpture. Next to *Lampsilis parvus*, it is the smallest species found in the region. The individuals from Hickory Creek are wonderfully uniform in shape and are readily identified by the peculiar swelling of the posterior part of the shell. This species also seems to be restricted to the Desplaines River and its tributaries, and is very abundant; when one is found, dozens or even hundreds of individuals may be found near by.

* * *

Ovules filling the entire outer gill of the female, ovisacs short, running crosswise of the gill. (Simpson.)

GENUS **ANODONTOIDES*** Simpson, 1898. New genus.

Shell: Elongate oval, inflated, thin, with a smooth, bright epidermis, which is often faintly rayed; beaks full, beak sculpture much as in Strophitus, but less developed and more delicate, consisting of a few concentric ridges with slight radiating ridges behind but not in front; hinge line slightly incurved in front of the beaks; teeth wanting or reduced to mere vestiges; nacre not brilliant.

Animal: Anal opening furnished with distinct papillæ; all four gills filled with embryos; inner branchiæ united, wholly or in part, with the abdominal sac. (Simpson.)

13. **Anodontoides ferussacianus** Lea, pl. iii., fig. 6; pl. v., fig. 2.
Anodonta ferussaciana LEA, Trans. Amer. Phil. Soc., 2d series, Vol. V., p. 45, pl. vi., fig. 15, 1837.

Shell: Rather thin, moderately inflated (much inflated posteriorly in the female); elliptical, rounded before and obtusely angled, or rounded behind; dorsal margin straight, ventral margin rounded; surface marked by rather coarse lines of growth; umbones a trifle elevated, inflated, greenish gold in color when not eroded, and marked by three or four small, but well defined ridges directed anteriorly; anterior umbonal slope short and rounded; posterior slope long and somewhat flattened; ligament weak, light brown in color; epidermis light green, yellowish green or brownish, with numerous wide, dark green rays, extending from the umbones to the ventral margin; the umbones are not rayed; there is generally a dark brown line near the ventral border in the young, marking an old rest period; hinge line straight, feeble, only very slightly thickened, the cardinal teeth but slightly developed; muscle scars and pallial line very faint; cavity of the beaks shallow; nacre bluish white, iridescent.

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*The writer used the name *Anodontopsis* for this genus in his mollusks of Western New York (Trans. Acad. Sci. St. Louis, Vol. VIII., p. 76); Mr. Simpson has since stated that the name was preoccupied by McCoy for a genus of fossil Pelecypoda, hence the change of the name as above.

Length,	56.00;	height,	32.50;	breadth,	21.00	mill.	♂	(9841).
"	55.00;	"	29.00;	"	21.00	"	♂	(9841).
"	71.00;	"	40.00;	"	27.00	"	♂	(8422).
"	81.00;	"	42.00;	"	40.00	"	♀	(coll. Jensen).
"	74.00;	"	39.00;	"	29.00	"	♂	" " .

Animal: Generally light flesh color or white and transparent; ctenidia very wide but not very long, yellowish white, rounded at both ends, united above throughout their entire length; right and left pair not entirely united, leaving a space about half an inch, where they hang free; all four bronchiæ filled with ovules in the female; labial palpi wide, large, tongue shaped, dark flesh color with a patch of yellowish white on the dorsal margin, united at base; siphons thick, papillose variegated with cinnamon brown, the extreme border edged with black; mantle white and transparent, edged with black; liver dark brown; abdomen pearly white; foot large and muscular; heart pulsation regular, sixteen per minute.

Distribution: Mississippi River drainage and St. Lawrence drainage. New York west to Dakota, Southern Canada south to Texas.

Geological distribution: Pleistocene.

Habitat: Found commonly in lakes and rivers, on a muddy bottom.

Remarks: Distinguished from all other species found in this region by its grass green color, minute umbonal sculpture and delicate rays. It is found associated with *S. edentulus*, *A. grandis*, *A. pressus* and *L. luteolus*, all of which are mud loving species. As the shell increases with age, the greenish epidermis is replaced by a brownish covering without rays. The females generally have a more inflated shell posteriorly than the male.

Mr. Simpson remarks as follows on gravid examples of this species which he has examined: "I found examples of *A. ferussaciana* in which all four of the gills were filled with embryos, the outer enormously distended, the inner moderately filled. I have found others in which only the outer gill was filled, and still others with the outer gill only partly filled. The inner gill may empty first or it may be filled only under favorable circumstances."

14. **Anodontoides subcylindraceus** Lea, pl. iv., fig. 4; pl. vi., fig. 1,
Anodonta subcylindracea LEA, Trans. Amer. Phil. Soc., 2d series, Vol. VI., p. 106, pl. xxiv., fig. 117, 1839.

Shell: Somewhat thin, subcylindrical or elliptical, rounded before and triangulate behind, the apex of the angle truncated or rounded; dorsal and ventral margins nearly straight in the female, and ventral border rounded in the male; surface marked by distinct lines of growth, with several dark lines marking former rest periods; umbones but little elevated, rusty brown or greenish gold in color, but generally eroded, and with four small distinct elevated ridges, directed anteriorly; posterior slope almost flat, subangulated, but not much excavated; ligament rather short, narrow, dark horn color; epidermis greenish or greenish yellow, varying from plain to rayed, the green rays being numerous, rather wide, and radiating from the umbones to the ventral border; hinge line straight, a trifle thickened, with a bare indication of cardinal teeth anterior to the umbones; muscle scars and pallial line distinct but not impressed; cavity of the beaks shallow; nacre silvery white, with a shade of bluish, sometimes pure white under the beaks, iridescent.

Length, 69.00; height, 36.00; breadth, 26.00 mill. ♂ (12948).
" 63.00; " 32.00; " 24.50 " ♀ (coll. Jensen).
" 74.00; " 38.00; " 29.50 " ♂ (13032).

Animal: Generally whitish or yellowish; mantle white edged with brownish black, the tentacular portion darker; ctenidia long and narrow, rounded at both ends and united above their entire length, yellowish in color; labial palpi rounded, not large, united at base, yellowish in color; foot of good size, whitish or yellowish; the abdomen whitish; tentacles small, blackish brown. The outer gills were distended with young April 12, 1897, and were of a deep chocolate color. Glocidia, as well as eggs in the morula stage, were very numerous, the former very active. Normally all four gills are used as marsupia.

Distribution: Illinois and Michigan to Ohio and western New York.

Geological distribution: Pleistocene.

Habitat: In small rivers and creeks, on a muddy bottom.

Remarks: This species may be distinguished from *A. ferussacianus*, with which it is very closely related and may be but a variety, by the greenish gold color of the umbones and its general cylindroid shape. The males are not so cylindrical as the females, and have the posterior end very pointed while in the female it is rounded. The species also varies in color, some being plain yellowish brown, while others are greenish yellow rayed with grass green. It is not as common as *ferussacianus*, and is found in the Desplaines River and its tributaries, the north branch of the Chicago River and Lake Michigan. Some forms are of a uniform yellowish horn color, without rays of any kind.

* * *

Ovules filling all four gills of female, ovisacs not separated by a sulcus. (Simpson.)

GENUS **QUADRULA** Rafinesque, 1820.

Shell: Solid, triangular to rhomboidal with a well developed posterior ridge and generally dark or only feebly rayed epidermis, and in age often showing a tendency to become arcuate on the base; beaks high, usually curved forward, their sculpture consisting of a few rather heavy ridges, either nearly parallel with the growth lines or showing a tendency to fall into an anterior and posterior loop; hinge plate heavy, with the teeth arranged much as in *Plagiola;* cavity of the beaks deep and compressed; muscle scars well defined, anterior scar deep. There is often in this genus a decided lunule under and just in front of the beaks which is most conspicuous in the more solid, inflated forms.

Animal: Anal opening with only minute papillæ or none; all four gills of the female being transformed throughout into marsupia when gravid; ovisacs not separated by a sulcus; inner gill generally free from the abdominal sac. (Simpson.)

GROUP OF QUADRULA TRIGONA.

15. **Quadrula trigona** Lea, pl. xv., fig. 5.

Unio trigonus LEA, Trans. Amer. Phil. Soc., Vol. IV., p. 110, pl. xvi., fig. 40, 1831.

Unio chunii LEA, Jour. Phil. Acad., Vol. V., p. 196, pl. xxvii., fig. 265, 1862.

Unio riddellii LEA, Jour. Phil. Acad., Vol. V., pp. 197-8, pl. xxvii., fig. 267, 1862.

Shell: Trigonal, thick and heavy, much inflated, broadly rounded before and behind, the posterior margin being produced ventrally; dorsal margin curved, ventral margin more or less sinuous; surface more or less shining, roughened by lines of growth; umbones large, elevated, inflated, dark brown, directed anteriorly and unmarked except by growth lines; anterior umbonal slope short and flatly rounded, posterior slope strongly angled, with an excavation on each side of the angle which reaches from the apex to the ventral border, where it forms a decided beak-like projection; viewed anteriorly the shell is strongly heart shaped, resembling in this respect some cardia, particularly *Isocardia cor;* ligament short, wide, stout, very dark brown or black; epidermis reddish or blackish horn, unmarked by rays; cardinal teeth double in the left and single in the right valve, very stout, generally not much elevated, triangular, diverging, very deeply grooved and striated; lateral teeth short, solid, elevated, lamellar, serrated, directed and curved ventrally; the right lateral and the lower left lateral have each a depression and rudiment of an additional tooth; connecting bridge thick, wide, flat, smooth; anterior adductor muscle scar forming a truncated oval, very deeply excavated, striated; posterior adductor muscle scar oval, well impressed, striated; *protractor pedis* muscle scar wider than long, deeply impressed, striated; *retractor pedis* muscle scar oval, very deeply pitted, striated; dorsal muscle scars situated on the posterior face of the cardinal teeth and the under side of the connecting bridge, deep, large; pallial line impressed; cavity of the beaks deep; nacre silvery white, more or less iridescent.

Length, 47.00; height, 50.00; breadth, 40.00 mill. Mississippi River, Wis.
" 51.50; " 45.00; " 39.00 " " " "
" 60.00; " 43.00; " 30.00 " Calumet River (Hybrid ?).

Animal: Anal opening small, only slightly crenulated; branchial opening with stumpy brown papillæ; inner gill the larger, ashy salmon, free from the abdominal sac; all four gills moderately filled with embryos throughout. (Simpson.)

Distribution: "Western New York to Minnesota, and Iowa, and Kansas; to Texas, east to Mississippi and Tennessee." (Call.)

Geological distribution: Pleistocene.

Habitat: In the larger rivers, on a muddy bottom, in rather deep water.

Remarks: A very distinct species, at once recognized by its heavy trigonal form, elevated umbones and cordate appearance when viewed anteriorly. Specimens have been found fossil on an old lake beach, now half a mile from the lake, while digging foundations for new buildings. They were found at a depth of from five to ten feet below the surface. One specimen found while digging a cellar on Hall Street seems to be intermediate between *trigona* and *rubiginosa;* it has the length and height of *rubiginosa* and the trigonal and inflated shape of *trigona.* The cardinal teeth are more elevated and deeply sulcated in some specimens than in others, and some forms are longer in proportion to their height. So far as known it is found only in the Calumet River, in which stream Messrs. T. Jensen and H. B. Derr found each a single dead specimen. The individual collected by Mr. Derr seems to be a cross between *rubiginosa* and *trigona,* having the length and general shape of the former and the inflated and elevated umbones of the latter.

16. **Quadrula rubiginosa** Lea, pl. xix., fig. 2; pl. xx., fig. 1.

Unio rubiginosus LEA, Trans. Amer. Phil. Soc., Vol. III., p. 409, pl. viii., fig. 10, 1829.

Unio flavus RAFINESQUE, Conrad in monograph, p. 74, pl. xli., fig. 2, 1837.

Shell: Elliptical or quadrate, rather thick, compressed, sometimes constricted in the center of the shell, incrassate, rounded before, squarely truncated behind; dorsal border slightly curved; ventral border straight or curved; surface roughened by lines of growth, which are elevated into sharp ridges; umbones a trifle elevated, inflated, light yellowish brown, marked by five or six heavy, elevated, rounded ridges; anterior umbonal slope rounded; posterior slope angulated, excavated in some specimens; ligament short, wide, solid, very dark brown; epidermis dark horn colored or yellowish, darker in old specimens, and with very faint indications of rays in young specimens; cardinal teeth double in both valves, about equal in the left valve, and the anterior tooth small and rudimentary in the right, all stout, heavy, a trifle elevated, triangular, very heavily sulcated; lateral teeth long, wide, thick, heavy, pyramidal when studied in cross-section, serrated, directed toward the ventral margin; connecting plate between cardinal and lateral teeth flat, thick, not much spreading; anterior adductor muscle scar mussel shaped, very deeply excavated, concentrically and longitudinally striated; posterior adductor muscle scar rounded, impressed, concentrically striated; *protractor pedis* muscle scar wider than long, deeply impressed, striated; dorsal muscle scars situated on the posterior face of the cardinal teeth, deeply impressed; pallial line crenulated, impressed; cavity of the beaks deep; nacre silvery white with a tinge of salmon near the cavity of the beaks, and on the anterior part, iridescent.

Length, 64.00; height, 45.00; breadth, 27.00 mill. (8369).
" 69.00; " 49.00; " 30.50 " (7764).
" 40.00; " 30.00; " 22.50 " (7764).
" 79 00; " 60.00; " 33.00 " (13441).

Animal: Generally brownish slate color, except on the foot which is dark flesh or salmon; ctenidia short and wide, rounded before and behind, united above, and to the opposite pair, throughout their entire length, the inner one the larger; color of ctenidia bluish; labial palpi tongue shaped, united at base and for a short distance posteriorly; foot very thick; siphonal openings brownish, the anal small and almost smooth; the branchial larger, with dark flesh or salmon colored papillæ; edge of mantle brown; liver yellowish brown; between the beaks and the pericardium the animal is bluish white. The abdomen is of a beautiful pearl color, and the mantle is sometimes pink or salmon colored. Four gills used as marsupia.

Distribution: New York west to Iowa, Michigan south to Louisiana and Alabama.

Geological distribution: Pleistocene.

Habitat: Found rather plentifully in the larger rivers, on a muddy bottom, in water from a foot to twenty feet or more in depth.

Remarks: A species showing considerable variation, especially in the shape of the posterior portion, and in its corpulency. It is always dark colored. Some specimens approach very closely to *trigona*. The form is also confounded, by many conchologists, with *coccinea*, but that species is more rounded and lacks the angulate character of the posterior slope; the cardinal teeth also present some differences, being more massive and diverging in *coccinea* than in the present species. The plate of the lateral teeth is also broader in *coccinea*. Specimens examined June 2, 1897, had both gills filled with embryos.

17. **Quadrula coccinea** Lea, pl. xiv., fig. 1; pl. xix., fig. 3.

Unio coccineus Lea, Trans. Amer. Phil. Soc., Vol. VI., p. 12, pl. v., fig. 12, 1834.

Unio gouldii (*gouldianus*) Lea, Trans. Amer. Phil. Soc., Vol. X., p. 76, pl. vi., fig. 16, 1845.

Shell: Roundly quadrate, or roundly elliptical, somewhat compressed, thick and solid; rounded before, squarely truncated behind, sometimes much produced; dorsal and ventral borders curved; surface roughened by growth lines which are more or less sharp and elevated; umbones elevated, rather compressed, reddish brown, marked by three large, elevated, undulating wrinkles and numerous fine growth lines; anterior umbonal slope rounded, posterior slope flat, subangulated, and sometimes excavated; ligament short, wide, strong, very dark brown or horn; epidermis brownish or reddish brown, shining; cardinal teeth double in both valves, nearly equal in the left, the anterior tooth but a rudiment in the right valve, all depressed, triangular, thick, heavy, strongly serrated, the anterior tooth in the left valve being long and narrow; lateral teeth rather long, elevated, lamellar, serrated, directed ventrally; the single lateral in the right valve has a depression into which the ventral tooth in the left valve fits; connecting plate between the teeth wide and spreading, thin, flat, smooth; anterior adductor muscle scar a little longer than wide, deeply excavated, rounded below, truncated above, striated; posterior adductor muscle scar roundly quadrate, slightly impressed, striate, confluent; *protractor pedis* muscle scar wider than long, very deeply excavated, striated; dorsal muscle scars situated on the posterior face of the posterior cardinal tooth in the left valve very deep, long and narrow; cavity of the beaks shallow; pallial line barely visible; nacre rose, pink or salmon pink, iridescent; in some specimens the nacre is white.

Length,	52 50;	height,	39.50;	breadth,	20.00	mill.	(10088).
"	61.00;	"	56.00;	"	33.00	"	(12992). Hybrid.
"	71.00;	"	50 00;	"	28.00	"	(12944).
"	66.00;	"	54.00;	"	32.00	"	(12944).

Animal: Generally a delicate flesh color, shading to bluish white about the adductor muscles and a part of the foot and abdomen, which latter is yellowish; ctenidia short and wide, rounded before and behind, united above and to the opposite pair throughout their entire length; labial palpi triangular, yellowish at base and bluish white at tip, united at base and partly on the posterior side; foot large, flesh colored; siphonal openings yellowish inside shading to brownish; anal opening slightly crenulated, small; branchial with numerous brownish or blackish papillæ; edge of mantle black; liver dark brown. Four gills used as marsupia.

Distribution: Mississippi and Ohio valleys.

Geological distribution: Pleistocene.

Habitat: In rivers, in soft, black mud.

Remarks: This species is closely related to *Q. rubiginosa*, but may be distinguished by its inflated umbones, roundly elliptical shell, produced postero-ventral margin and its heavy cardinal teeth. In some specimens the pink nacre serves as a distinguishing character, but only about thirty per cent are thus colored, the others having a white nacre. The young more nearly resemble *rubiginosa*, but as they beome older the characters of *coccinea* become more pronounced. In the DuPage River a form is sparingly found, which Prof. R. E. Call says is a cross between this species and either *trigona* or *rubiginosa*. As *rubiginosa* is the only other form of this group found in the DuPage River, the cross must be between these two species. The cross has a thicker and more quadrate shell than the typical form. This is a very significant fact, which may account for much of the perplexity attending the identification of the Unionidæ. The species seems to be confined to the Desplaines River drainage.

GROUP OF QUADRULA PLICATA.

18. **Quadrula plicata** Lesueur, pl. xxvi., fig. 1.

Unio plicatus LESUEUR, Lea, Trans. Amer. Phil. Soc., Vol. III., p. 409, 1829.

Unio rariplicata LAMARCK, Animaux sans vertebres, ed. 1818, Vol. VI., p. 71.

Unio hippopæus LEA, Trans. Amer. Phil. Soc., 2d series, Vol. X., p 67, pl. i., fig. 1, 1845.

Shell: Broadly elliptical, plicate, very thick and solid, inflated, rounded before and quadrate behind; dorsal and ventral borders almost straight; surface heavily marked by growth lines and by from four to six rather heavy plications which extend in a diagonal direction across the shell, passing from the upper part of the shell toward the ventral part; umbones large, elevated, inflated, dark horn color, marked by about five fine, diverging wrinkles; anterior umbonal slope rounded, short; posterior slope long, obtusely angular, excavated; ligament long, wide, stout, very dark brown or horn color; epidermis black or reddish brown; cardinal teeth double in both valves, the anterior smallest in both valves, but that in the right valve much smaller; all depressed, stout, triangular, very deeply grooved and channeled; lateral teeth long, stout, thick, elevated, serrated, directed ventrally; connecting plate thick, wide, smooth; anterior adductor muscle scar kidney shaped, very deeply impressed, very strongly marked by elevated ridges; posterior adductor muscle scar truncated-oval, distinct but not much impressed, striated; *protractor pedis* muscle scar wider than long, very deeply excavated, striated and strongly pitted; dorsal muscle scars large, very deeply impressed, one in each valve situated on the under side of the connecting bridge; pallial line crenulated, impressed; cavity of the beaks deep; nacre silvery white, pearly on the posterior portion.

Length,	79.00;	height,	64.00;	breadth,	50.00	mill.	(coll. Handwerk).
"	80.00;	"	63.00;	"	52,00	"	(13003).

Animal: Anal opening very large, only slightly crenulated; branchial opening very large with many small papillæ; palpi long and falcate, united above and behind; gills large, inner much the larger, free from the greater part of the abdominal sac; not gravid. (Simpson.)

Distribution: Western New York to Arkansas and Iowa, Michigan to Alabama and Texas.

Geological distribution: Pleistocene.

Habitat: In the larger rivers, in rather deep water, generally on a muddy bottom.

Remarks: Plicata is generally confounded with *undulata* Barnes, but there is no good reason for this,.as they are quite distinct and easily separated. *Plicata* is always strongly inflated at the umbones, which are much elevated, and the shell is generally broader than *undulata*. The undulations are fewer in the present species and are differently arranged. In *undulata* the umbones are flat and depressed, and the whole shell is compressed. The cardinal teeth are proportionately heavier in the present species. It does not seem to be very common in this area, and is confined to the lower part of the Desplaines River.

19. **Quadrula undulata** Barnes, pl. xxii., fig. 1, 2; pl. xii., fig. 1.
Unio undulatus BARNES, Am. Jour. of Sci. and Arts, 1st series, Vol. VI., p. 120, fig. 2, 1823.
Unio costatus RAFINESQUE, Conrad, Monograph of Unio, p. 17, pl. vii., 1836.
Unio latecostatus LEA, Trans. Am. Phil. Soc., Vol. X., p. 68, pl. i., fig. 2, 1845.
Unio pilsbryi MARSH, The Nautilus, Vol. V., p. 1, 1891; Vol. VII., pl. i., figs. 7, 8, 1893 (vide Call).

Shell: Quadrately elliptical, undulate, compressed, very thick and heavy, rounded before and obtusely triangular behind; dorsal margin straight, ventral margin slightly rounded; surface roughened by lines of growth which are raised into thin scales on the ventral border; umbones not elevated, somewhat inflated, brownish horn color, marked by five coarse, diverging, rounded ridges; anterior umbonal slope short, rounded; posterior slope long, flatly rounded; ligament long, narrow, thick, reddish or blackish horn color; epidermis reddish brown or blackish; the whole surface of the shell is marked by coarse undulations extending in a diagonal direction across the surface, in most specimens bifurcating; five or six large undulations are generally present with several smaller ones; cardinal teeth double in both valves, about equal in the left, and the anterior much the smaller in the right valve, all but the latter heavy, thick, triangular, diverging, very deeply striated and grooved; lateral teeth long, thick, more or less elevated, slightly curved ventrally, serrated; connecting plate between the teeth thick, flat, smooth; adductor muscles and *protractor pedis* scar as in *plicata;* dorsal muscle scars numerous, of good size, deeply pitted, situated on the posterior face of the cardinal tooth and on the under side of the connecting plate; pallial line very deeply impressed, crenulated; cavity of the beaks broad, shallow; nacre silvery white, iridescent on the posterior portion.

Length,	131.00;	height,	88 00;	breadth,	52 00	mill.	(9321).
"	86.00;	"	65.00;	"	33.00	"	(9347).
"	83.00;	"	60.00;	"	31.50	"	(9526).
"	150.00;	"	108.00:	"	60.00	"	(coll. Jensen).

Animal: Creamy white, light brown on abdomen and upper portions; anal and branchial openings large, the former slightly crenulated and the latter with numerous small papillæ; posterior part of mantle yellowish brown, edged with black, especially near the two siphons; liver darker in color than the abdomen; ctenidia short and wide, rather pointed behind, rounded before, the inner ctenidium the larger, united above throughout their entire length; labial palpi large, elongately oval or tongue shaped, united as is usual in this genus; foot large and muscular; pulsations of the heart very regular, eleven to twelve per minute. Four gills used as marsupia.

Distribution: New York and Georgia west to Kansas and Dakota, Michigan south to Texas.

Geological distribution: Pleistocene.

Habitat: Same as that of *Unio gibbosus.*

Remarks: The writer has noted the principal differences between this species and *plicata* under the latter species. There was considerable variation among the specimens of this species examined. The second cardinal in the right valve may be almost half as large as the posterior cardinal or it may be absent; there is also every degree of undulation, from a condition almost smooth (9347) to one in which the ridges are large and finely developed. *Unio pilsbryi* Marsh seems to be founded on one of these variations. This is a rather common species and is widely distributed, being found in most parts of the area. It has been found fossil in a cellar dug on the corner of Frederick and North Clark Streets, about half a mile from the present lake shore. Very large and fine specimens weighing 1 lb. 10 oz. have been collected by Mr. Jensen in the Little Calumet River. The specimens from this locality are very rugose and show a tendency toward *Q. multiplicata.*

GROUP OF QUADRULA LACHRYMOSA.

20. **Quadrula lachrymosa** Lea, pl. xxiv., fig 1; pl. xii., fig. 2.

Unio lachrymosus LEA, Trans. Amer. Phil. Soc., Vol. III., p. 272, pl. vi., fig. 8, 1827.

Unio asperrimus LEA, Trans. Amer. Phil. Soc., Vol. IV., p. 71, pl. v., fig. 3, 1830-1.

Unio quadratus, RAFINESQUE, Say, Amer. Conch., pl. lii., 1834.

Unio lunulatus PRATT, Proc. Davenport Acad. Sci., Vol. I., pl. xxxi., fig. 1, 1870.

Shell: Quadrate, compressed, solid and heavy, pustulose; rounded before and squarely truncated behind; dorsal margin straight or slightly curved; ventral portion with an excavation near the posterior end; surface roughened by growth lines and covered with pustules which are arranged in two series on either side of a smooth depression situated in the center of the shell, and extending from the umbones to the ventral border, at the excavation spoken of above; the anterior set of pustules is arranged in a narrow line, but the posterior set covers all of the posterior part where they are long and narrow and directed toward the posterior border; the majority of the pustules are small and rounded, but there are one or two very large ones near the ventral and central part which are longer than wide; the pustules are more numerous about the umbonal region than on any other part of the shell and the anterior part of the shell is always free from them; umbones small, compressed, light brown, marked by numerous small pustules; anterior umbonal slope rounded, posterior slope pustulose, forming an angle; ligament short, wide, solid, very dark brown; epidermis yellowish green, obscurely rayed with dark green; cardinal teeth stout, triangular, diverging, heavily grooved, double in both valves as in *reflexa;* lateral teeth long, narrow, serrated, directed ventrally; connecting bridge solid, flat, smooth; anterior adductor muscle scar forming a truncated oval, deeply impressed, striated; posterior adductor muscle scar scarcely visible, confluent; *protractor pedis* muscle scar oval, deeply impressed, striated; dorsal muscle scars numerous, small (large exceptionally), deeply pitted, situated on the posterior face of the cardinal teeth and on the under side of the connecting bridge; pallial line impressed, especially anteriorly, crenulated; cavity of the beaks deep; nacre silvery white, iridescent, especially on the posterior part of the shell.

Length, 60.00; height, 47.00; breadth, 28.00 mill. (9696).
" 68.00; " 53.50; " 25.00 " (13088).
" 86.00; " 70.00; " 39.00 " (13442).
" 30.00; " 21.00; " 13.00 " (13442 juv.)

Animal: Pearly white, tinged with flesh color; ctenidia small, long and somewhat narrow, rounded at both ends, the inner one the larger, united above for their entire length, but the opposite pair united to its fellow pair for but three-quarters of the distance; color of gills light flesh; labial palpi of same color as gills, large and wide, tongue shaped, united at base; foot rather large, flesh colored; abdomen pearl colored, tinged with flesh, sometimes iridescent; mantle pearly or flesh colored, with a line of pearl colored vertical fibers running clear around near the border; the ventral border edged with brown; anal and branchial openings large, brownish, the former crenulated and the latter papillose; liver brownish; heart very active and regular, pulsations thirty-one to thirty-three per minute. Four gills used as marsupia.

Distribution: Western New York to Kansas and Minnesota, and south to Texas and Alabama. (Call.)

Geological distribution: Pleistocene.

Habitat: Found in the larger lakes and rivers, on a muddy or sandy bottom, in somewhat shallow water.

Remarks: This is a characteristic and somewhat rare species in this area, and it is one of our most beautiful Unios. The pustulate character of the posterior margin is quite unique, some of the larger pustules being shaped like the nodules in *Obliquaria reflexa.* So far as known, it is confined to the southern region, and the specimens are of medium size, yellowish green faintly rayed with grass green. In old specimens the shell becomes a dark chestnut brown.

GROUP OF QUADRULA PUSTULOSA.

21. **Quadrula verrucosa** Barnes, pl. xxiii.

Unio verrucosus BARNES, Amer. Journ. Sci. and Art, 1st series, Vol. VI., p. 123, fig. 6, 1823.

Shell: Ovately quadrate, thick, heavy, pustulate, compressed, rounded before and squarely truncated behind; dorsal margin nearly straight, ventral margin generally rounded but sometimes nearly straight; surface strongly roughened by growth lines and profusely covered with tubercles and pustules on all but the anterior portion, the pustules being wider than long and following the direction of the growth lines; the pustules are more numerous in the center of the shell than elsewhere; umbones small, prominent but not elevated, somewhat inflated, strongly directed anteriorly, brown in color, marked by numerous heavy, wavy ridges, which extend for a considerable distance toward the ventral part of the umbonal slope; anterior umbonal slope rounded, posterior flat, somewhat alate, or slightly excavated, forming a shoulder; ligament long, wide, stout, very dark horn color; epidermis uniform dark brown; cardinal teeth single in the right and double in the left (there is almost always a very small tooth-like projection in the right valve, near the lunule, which is without doubt a rudimentary second cardinal), flattened, large, solid, triangular, deeply grooved, diverging in the left valve; lateral teeth short, very strong, striated, directed ventrally; connecting bridge broad, flat, smooth and solid; the shell extends above and posterior to the lateral teeth and forms a flat, alate projection; anterior adductor muscle scar oval, deeply excavated, heavily striated; posterior adductor muscle scar rounded, slightly impressed, striated, confluent; *protractor pedis* muscle scar wider than long, very deeply excavated, striated; dorsal muscle scars situated on the posterior face of the cardinal teeth, under the connecting bridge, numerous, rounded, deeply pitted; pallial line deeply impressed anteriorly, crenulated; cavity of the beaks deep; nacre varying between mauve and purple, iridescent on the posterior portion, having a satin finish near the cavity of the beaks.

Length, 83.00; height, 66.00; breadth, 35.00 mill. ♀ (8090).
" 64.50; " 58.00; " 27.00 " ♂ (8090).

Animal: Anal opening small with no papillæ; branchial opening very large, with many small brown papillæ; palpi subtriangular, united one-half way posteriorly; branchiæ not large, nearly semicircular, inner one the larger, free nearly two-thirds of the length of the abdominal sac; marsupia not developed. (Simpson.)

Distribution: Found generally throughout the Mississippi Valley and in the Ohio Valley.

Geological distribution: Pleistocene.

Habitat: Found plentifully in the larger lakes and rivers, on a muddy bottom.

Remarks: A characteristic species which bears no particular resemblance to any other mollusk found in the area. It is confined to the southern region, where it is found of large size and fine coloration.

22. **Quadrula pustulosa** Lea, pl. xxiv., fig. 2; pl. xxv.; pl. xxvii., fig. 13.

Unio pustulosus LEA, Trans. Amer. Phil. Soc., Vol. IV., p. 64, pl. viii., fig. 7, 1830.

Unio schoolcraftensis (*schoolcraftii*) LEA, Trans. Amer. Phil. Soc., Vol. V., p. 37, pl. iii., fig. 9, 1832.

Unio prasinus CONRAD, New Fresh-water Shells of the United States, p. 44, pl. iii., fig. 1, 1834.

Unio dorfeuillianus LEA, Trans. Amer. Phil. Soc., Vol. VI., p. 73, pl. xvii., fig. 54, 1836.

Unio mortoni CONRAD, Monograph of Unio, p. 11, pl. vi., fig. 1, 1836.

Unio bullatus RAFINESQUE, Conrad, Monograph of Unio, pl. xl., fig. 2, 1838.

Unio pernodosus LEA, Trans. Amer. Phil. Soc., Vol. X., p. 71, pl. iii., fig. 8, 1845.

Unio asperatus LEA, Journ. Phil. Acad., 2d series, Vol. V., p. 68, pl. vii., fig. 218, 1861.

Shell: Orbicular, sometimes inclining to quadrate, inflated, thick, heavy; dorsal border slightly curved, ventral border curved; rounded before, broadly rounded or truncated behind; surface roughened by lines of growth and marked with pustules, which may be very few or very numerous, and may fill the entire valve or only a small portion of it; the pustules vary in size and are either small or rounded knobs or long and narrow ridges; anterior umbonal slope rounded, posterior slope flattened or rounded, sometimes excavated; umbones varying from elevated to depressed, inflated, light greenish or brownish, marked by about four elevated ridges and numerous fine growth lines; the umbones are almost always eroded; ligament short, wide, stout, very dark horn, sometimes striped with a still darker color; epidermis varying from a uniform yellowish brown to yellowish with a broad band of dark green extending from the umbones to the ventral border, widening as it nears the latter region; in some specimens the green color is disposed on different parts of the shell in small patches; cardinal teeth double in both valves, equal in the left, the posterior the larger in the right valve, solid, triangular, deeply grooved, diverging; the cardinals are very variable, being wide or narrow, elevated or depressed, single or double, sulcated or almost smooth, and furnished with a number of accessory toothlets; lateral teeth short, stout, lamellar, elevated, serrated, directed ventrally; connecting bridge wide, thick, smooth or sulcated; anterior adductor muscle scar elliptical, very deeply excavated, strongly striated; posterior adductor muscle scar rounded, impressed, confluent, iridescent; *protractor pedis* scar as usual; dorsal muscle scars situated on the posterior face of the cardinal teeth, numerous, arranged in a straight line, deeply pitted; pallial line impressed, imbricated; cavity of the beaks deep; nacre pearly white, iridescent on the posterior region.

Length, 59.50; height, 58.00; breadth, 36.25 mill. (7763).
" 54.50; " 54.50; " 32.00 " (7763).
" 52.00; " 39.00; " 32.00 " ♀ (13444).

Animal: Generally flesh colored, lighter and darker in places; ctenidia short and wide, half-moon shaped, rounded at both ends, chocolate brown in color, united above and to the opposite pair for their entire length; the inner ctenidium is much the larger, and both are thickened posteriorly; labial palpi short, wide, ovate, adherent at base, in color like the ctenidia; foot whitish, tinged with yellowish or salmon; anal opening small, without papillæ; branchial large with small blackish papillæ; mantle yellowish brown, approaching to salmon, edged with black; liver and cardiac pouch brownish; heart with very regular pulsations, numbering twenty-three per minute. Four gills used as marsupia.

Distribution: Ohio and North Carolina west to Kansas and Iowa, Wisconsin south to Louisiana and Texas.

Geological distribution: Pleistocene.

Habitat: Found in the larger rivers and lakes, on a muddy bottom.

Remarks: This is one of the most variable of North American Unios, and has received a large number of names, as the synonymy on the previous page shows. The shell varies from entirely smooth or with few pustules (*schoolcraftii*) to a condition where the whole valve is covered with pustules, and the pustules may be long and narrow or round. The umbones vary from depressed to elevated and the cardinal teeth show a dozen or fifteen different modifications. The writer has before him at the present time nineteen different varieties of this shell, from a number of States. It is a common and widely diffused species, and with all its mutation, is easily recognized when once known. It is quite common in the southern region, in Calumet Lake and River, and is also found in the Desplaines River, near Joliet.

* * *

Ovisacs distinct, occupying a part of outer branchiæ of females. (Simpson.)

GENUS **OBLIQUARIA** (Rafinesque) Simpson, 1898.

Shell: Solid, inflated, oval in outline, obliquely truncated and pointed behind with a well developed posterior ridge; beaks prominent, sculptured with a few strong ridges which are heaviest where they cross the posterior ridge; posterior slope and sometimes the entire shell covered with wavy or chevron shaped folds; a row of three or four strong elevated nodules, compressed lengthwise, extends from the beaks down the center of the shell and the region behind this is somewhat excavated; epidermis bright and smooth, sometimes a little wrinkled, a uniform yellowish brown or painted with delicate broken green lines which often become zigzagged; left valve with two heavy pseudo-cardinals and two laterals, right valve with one strong pseudo-cardinal, with often a smaller one in front and behind it, and a single lateral sometimes with a supplementary one below; cavity of the beaks rather shallow; anterior part of the shell very solid, posterior part much thinner.

Animal: Anal opening with only slight crenulations, branchial opening having numerous papillæ; mantle very thin with a broad, thick margin; branchiæ small, round below, inner much the larger, free nearly its whole length from the abdominal sac; marsupium consisting of from six to ten distinct ovisacs about the center of the outer gill or just behind it, which, when gravid, project far below the rest of it. (Simpson.)

23. **Obliquaria reflexa** Rafinesque, pl. xiv., fig. 5; pl. xx., fig. 2.

Unio reflexus Rafinesque, Mon. des Coq. Biv. it Fluv. Ohio, p. 306, 1820.
Unio cornutus Barnes, Amer. Jour. Sci. and Arts, 1st series, Vol. VI., p. 122, figs. 5a, 5b, 1823.

Shell: Roundly ovate, thick, heavy, inflated, broadly rounded before, triangular behind; dorsal border rounded, ventral border with a profound bulge; surface smooth, the lines of growth being very fine, ornamented by four large nodules which are placed in the center of the surface on a line drawn from the umbones to the central bulge; on the umbones the nodules are rounded, but as they near the ventral border they become very long and narrow; umbones elevated, inflated, ornamented with four large nodules and numerous fine, concentric growth lines, color light brown; anterior umbonal slope very broad and rounded; posterior slope excavated, with a strong shoulder extending from the umbones to the ventral border, making the shell strongly angular; ligament short, very wide, strong, dark brown; epidermis light grass green, yellowish green or brownish; some specimens are marked by numerous wide green or black rays, which are made up of more or less interrupted lines or zigzag shaped marks; cardinal teeth double in both valves, equal in the left valve and the posterior tooth much the smaller in the right valve, massive, heavy, broadly triangular, diverging, very heavily grooved; lateral teeth short, thick, serrated, directed ventrally; connecting bridge very thick, broad, flat, smooth; anterior adductor muscle scar longer than wide, very deeply excavated, strongly striated; posterior adductor muscle scar rounded, impressed, striated, confluent, iridescent; *protractor pedis* muscle scar wider than long, deeply excavated, striated; dorsal muscle scars numerous, situated on the posterior face of the cardinal teeth, small, deeply pitted; pallial line impressed, crenulated; cavity of the beaks shallow; nacre silvery white, iridescent on the posterior part. The anterior part of the shell is much thicker than the posterior part.

Length, 49.50; height, 44.50; breadth, 29.50 mill. (1756).
" 47.00; " 46.00; " 30.00 " (1756).

Animal: Anal opening very small, apparently having small crenulations; branchial opening small with small thick set papillæ; branchiæ small, round below, inner the larger, free nearly the whole length of the abdominal sac; marsupium consisting of from four to six elongated ovisacs just behind the center of the outer gill. (Simpson.)

Distribution: Western New York west to Arkansas, Michigan south to Texas.

Geological distribution: Pleistocene.

Habitat: Found in rivers, in a few feet of water on a muddy bottom.

Remarks: *Reflexa* is a very distinct species, not to be confounded with any other form. It varies very much in its ornamentation from plain to strongly rayed, but the nodules seem to be very constant. It is a rare and very restricted species, at present only known from the Calumet River. The specimens from this locality are yellowish with fine black rays made up of small dashes of color placed longitudinally.

GENUS **PLAGIOLA** (Rafinesque) Agassiz, 1852.

Shell: Rather solid, somewhat triangular in outline, pointed posteriorly and having a sharply defined posterior ridge covered generally with a smooth epidermis which is often beautifully painted with wavy or zigzagged lines and markings; beaks not prominent, the region often being compressed; beak sculpture very faint, consisting of a few irregular corrugations; hinge line curved with two cardinals (pseudo-cardinals) and two laterals (pseudo-laterals) in the left valve, and one prominent cardinal (pseudo-cardinal) with sometimes one or two smaller ones, and one prominent lateral (pseudo-lateral), and a smaller inner one in the right valve. The female shell is generally slightly more inflated and developed in the postbasal region than that of the male, but in some cases it is extremely difficult to separate the sexes by the shell characters.

Animal: Branchial and anal openings provided with papillæ; posterior part of the outer gill of female used as a marsupium, having distinct ovisacs much like *Lampsilis;* inner gill partly free from abdominal sac; mantle often fringed in front of branchial opening. (Simpson.)

GROUP OF PLAGIOLA DONACIFORMIS.

24. **Plagiola donaciformis** Lea, pl. xiii., fig. 4.

Unio donaciformis LEA, Trans. Amer. Phil. Soc., Vol. III., p. 266, pl. iv., fig. 3, 1827. Male.

Unio zigzag LEA, Trans. Amer. Phil. Soc., Vol. III., p. 409, pl. xii., fig. 19, 1829. Female.

Shell: Elliptically elongated, thick and solid, inflated; dorsal margin almost straight; ventral margin rounded; rounded before, acutely biangular in the male and somewhat truncated in the female; surface smooth and shining, lines of growth indicated by obtuse ridges; umbones not much elevated but much inflated, yellowish or greenish in color, marked by very many fine elevated ridges; anterior umbonal slope rounded; posterior slope long, slightly excavated, shorter in the female than in the male, and forming a rounded ridge or shoulder; ligament short, rather wide, dark horn color; epidermis light green or yellowish green, with numerous rays composed of V-shaped dashes; in the female the dashes are frequently larger and form somewhat continuous rays; cardinal teeth double in the left and single in the right valve, small, elevated, narrow, more or less triangular, coarsely serrated; the single tooth in the right valve is acutely triangular; lateral teeth long, directed ventrally, lamelliform, almost straight, rather thick, striated; the right lateral has a small depression near the posterior end; bridge between the teeth arched, narrow, thick; anterior adductor muscle scar longer than wide, deeply excavated, striated; posterior adductor muscle scar ovate, scarcely visible, confluent; *protractor pedis* muscle scar wider than long, deeply impressed, striated; dorsal muscle scar situated in the cavity of the beaks, numerous, deeply excavated; pallial line slightly impressed; cavity of the beaks rather deep in most specimens; nacre silvery white, iridescent, especially on the posterior part.

Length, 48.00; height, 32.50; breadth, 23.00 mill. ♂ (8366).

Animal: Marsupium occupying posterior half of outer gill of female in numerous distinct ovisacs; branchiæ small, inner much the larger, nearly semicircular; free from abdominal sac only at posterior end; mantle with many brown papillæ on postbasal edge; branchial and anal openings small, each with many small brown papillæ; superanal opening rather large papillose. (Simpson.)

Distribution: Mississippi Valley, Michigan to Louisiana.

Geological distribution: Pleistocene.

Habitat: In rivers, on a muddy bottom.

Remarks: Donaciformis is easily distinguished by its zigzag epidermis. The males and females differ somewhat and have been described as distinct species. In the female the anterior end is rounded, projects beyond the umbones, which are elevated; the posterior end is short, truncated or obtusely biangular and considerably inflated. In the male the anterior end is short, while the posterior end is long and pointed, and somewhat compressed. It does not seem to be a common species, and but few specimens have been collected in the present area, where it is confined to the southern region.

25. **Plagiola elegans** Lea, pl. xxi., fig 1.

Unio elegans Lea, Trans. Amer. Phil. Soc., Vol. IV., p. 88, pl. ix., fig. 13, 1830-1.

Unio truncatus Rafinesque, Say in American Conchology, p. 67.

Shell: Trigonal, somewhat inflated, thick and solid, rounded before and obtusely biangulate behind; dorsal and ventral margins curved; surface smooth and shining, growth lines not prominent; umbones elevated, more or less inflated, yellowish or greenish in color, marked by several undulating, elevated ridges, generally eroded; anterior umbonal slope rounded, heart shaped when the valves are closed; posterior slope flat or excavated, separated from the sides of the shell by a strong ridge or shoulder; ligament short, wide, stout, dark brown or chestnut color; epidermis light yellowish green, with numerous dark green, zigzag rays, which are finer and smaller than in *donaciformis* (sometimes the rays are plain); cardinal teeth double in both valves, those in the left valve nearly equal, elevated, pyramidal or triangular, stout, serrated; those in the right valve unequal, the anterior being but a thickening of the hinge line, the posterior elevated, pyramidal, thick, striated; lateral teeth short, thin, lamelliform, serrated, curved ventrally; that in the right valve has a depression as in *donaciformis;* anterior adductor muscle scar squarish, deeply excavated, striated; posterior adductor muscle scar ovate, lightly impressed, confluent; *protractor pedis* muscle scar small, wider than long, deeply impressed and striated; dorsal muscle scars as in *donaciformis;* pallial line impressed; cavity of the beaks of good depth; nacre silvery white, sometimes tinged with light lavender, iridescent, especially on the posterior part.

Length, 36.00; height, 31.00; breadth, 17.00 mill. (1768).
" 33.50; " 24.00; " 18.00 " (1768).
" 52.00; " 39.00; " 24.00 " (13440).

Animal: Anal opening small, with dark papillæ; branchial opening with a few black papillæ; mantle thin, with a wide, thickened border which is double and *slightly* toothed below; inner gill the larger in front, united throughout to the abdominal sac; outer gill larger behind; marsupia occupying the posterior part of the outer gill in about fifty ovisacs with a longitudinal fold far above its base. (Simpson.)

Distribution: Mississippi and Ohio Valleys and Lake Michigan.

Geological distribution: Pleistocene.

Habitat: Similar to *donaciformis.*

Remarks: This is a species which is frequently confounded with *P. donaciformis.* It has a much more trigonal shell and the zigzag character of the rays differs from *donaciformis.* In the latter species the zigzags are large and coarse and the V-s long, and scattered over the surface in connected festoons; in *elegans* the zigzags are small, the V-s short and placed in a regular disconnected series of rays. When once known the two species need never be confused. In some rare specimens the rays are not composed of zigzag rays, but are straight and thread like. It is not a common species, and is restricted to the southern region.

Genus **LAMPSILIS** Rafinesque, 1820.

Shell: Oval to elongate, inflated, moderately solid, without a clearly defined posterior ridge, and never becoming arcuate with age, with a hard, bright, usually rayed epidermis; beak sculpture consisting for the most part of delicate parallel ridges which show a tendency to fall into an anterior and posterior loop. In the female the postbasal part of the shell is swollen opposite the part of the branchiæ which contains the embryos. Hinge containing two cardinals (pseudo-cardinals) and two laterals (pseudo-laterals) in the left valve, and one cardinal with sometimes a small second one above, and one lateral in the right valve.

Animal: Branchial opening papillose, anal opening generally having well developed papillæ; inner gills usually united to the abdominal sac throughout their length; posterior part of the outer branchiæ becoming developed into a marsupium, consisting of distinct ovisacs whose lower ends are rounded; marsupium rounded on its base and projecting below the inner gill. (Simpson.)

SECTION LAMPSILIS (typical).

GROUP OF LAMPSILIS VENTRICOSUS.

26. **Lampsilis ventricosus** Barnes, pl. xii., figs. 3, 4, 5.

Unio ventricosus BARNES, Amer. Jour. Sci. & Arts, 1st series, Vol. VI., p. 267, figs. 14a, 14b, 14c, 1823.

Unio accidens LEA, Trans. Amer. Phil. Soc., Vol. III., p. 435, pl. x., fig. 16, 1829.

Unio cardium RAFINESQUE, Conrad, Monograph of Unio, p. 7, 1834.

Unio satur LEA, Trans. Amer. Phil. Soc., 2d series, Vol. X., p. 265, pl. xvii., fig. 19, 1852.

Unio canadensis LEA, Jour. Phil. Acad., Vol. IV., p. 268, pl. xliv., fig. 148, 1859.

Unio subovatus LEA, Reeve, Conch. Icon., Vol., XVI., *Unio*, pl. lxxxv., fig. 456 (not the true *subovatus*).

Shell: Large, inflated, subovate or elongately ovate, thick and heavy, rounded before and broadly rounded behind, the male being obtusely biangulate; dorsal margin slightly curved; ventral margin curved; surface smooth and polished, growth lines prominent; the height of the shell posterior to the umbones is very much greater than immediately in front of them; umbones prominent, inflated, yellowish brown in color, marked by six coarse, elevated ridges; anterior umbonal slope short, rounded; posterior slope long, flat, forming a decided angle; ligament rather short, wide, stout, dark chestnut; epidermis yellowish or yellowish green, with a few rather wide (sometimes narrow) rays extending from the umbones to the ventral border (the posterior portion is almost without rays in some specimens); cardinal teeth double in the left valve and single in the right, longer than wide, elevated, striated; the hinge line near the cardinal in the right valve is slightly enlarged, and may represent a second cardinal; lateral teeth strong, heavy, elevated, lamellar, crenulated, slightly curved; connecting bridge arched, narrow, smooth; anterior adductor muscle scar longer than wide, deeply excavated, especially near the cardinal teeth, striated; posterior adductor muscle scar rounded, as wide as long, concentrically striated, not much impressed; *protractor pedis* muscle scar wider than long, deeply impressed, coarsely striated; dorsal muscle scars situated on the posterior face of the cardinal teeth and the under surface of the connecting plate, large, deeply excavated; pallial line deeply impressed anteriorly; cavity of the beaks deep; nacre silvery white, only slightly iridescent.

Length,	117.50;	height,	70.00;	breadth,	51.50	mill.	♂ (9319).
"	97.00;	"	65.00;	"	41.50	"	♀ (8054).
"	112.00;	"	73.00;	"	48.50	"	♀ (12425).
"	153.00;	"	93.00;	"	62.00	"	♂ (coll. Jensen).
"	107.00;	"	72.00;	"	56.00	"	♀ " "

Animal: Generally pearly white or flesh colored; anal and branchial openings of moderate size, both papillose; ctenidia long and wide, rounded before, pointed behind, strongly laminated, united above and to the opposite pair throughout their entire length; labial palpi long, wide, tongue shaped, united at base, light pearly or flesh colored; foot large and muscular, flesh colored; abdomen pearly and iridescent; mantle pearly white, edged with brown; siphons yellowish white inside, edged with blackish brown; in all of the specimens examined by the writer the posterior part of the abdomen was supplied with a small triangular appendage of unknown function; liver dark brown; heart pulsations regular, seventeen to eighteen per minute. The posterior half of the outer branchium is used as a marsupium.

Distribution: New York west to Iowa, southern Canada south to Louisiana.

Geological distribution: Pleistocene.

Habitat: In lakes and rivers of some size, generally on a muddy bottom.

Remarks: A very distinct species, like no other in the region, the peculiar slope of the posterior portion of the shell at once distinguishing it. The female is more produced posteriorly than the male, the latter having the posterior end much sharper, and also having a peculiar bulge in the ventral part of the shell, just posterior to the center. The rays vary from very narrow threads to wide bands and are placed differently from any other species. It seems to be rather widely distributed in the area, and is fairly common. A specimen from the Little Calumet River, collected by Mr. Jensen, weighed one pound and one and a half ounces when alive.

27. **Lampsilis multiradiatus** Lea, pl. xxi , figs. 2, 3.

Unio multiradiatus LEA, Trans. Amer. Phil. Soc., Vol. III., p. 409, pl. ix., fig. 15, 1829.

Shell: Subovate, of medium size, rather solid, inflated, rounded before and broadly elliptical behind, the female broader than the male; dorsal and ventral margins curved; surface smooth and shining; growth lines prominent near the ventral border; umbones not elevated, inflated, dark reddish brown in color, and marked by five elevated, undulating ridges, causing the umbo to resemble a miniature *Quadrula plicata;* anterior umbonal slope rounded, posterior slope broadly rounded; ligament short, wide, stout, dark chestnut color; epidermis yellowish green, tinged with dark red, and marked by very many dark green rays, which are wavy in outline and vary greatly in width; cardinal teeth double in both valves, nearly equal in the left, and the anterior tooth very small in the right, elevated, triangular, serrated on the edge, all pointed forward; the anterior tooth in the right valve is indicated only by a thickening of the margin; lateral teeth short, thin, lamelliform, more elevated in the center than at each end, striated; anterior adductor muscle scar much longer than wide, very deeply impressed, coarsely striated; posterior adductor muscle scar rounded, as wide as long, not deeply impressed, concentrically striated, confluent; *protractor pedis* muscle scar wider than long, deeply impressed, striated, longer at the anterior than at the posterior end; dorsal muscle scars situated in the cavity of the beaks and on the posterior face of the cardinal teeth, numerous, deeply pitted; cavity of the beaks rather deep; pallial line very wide, impressed; nacre silvery white, iridescent, especially on the posterior part, showing the rays through the shell on the ventral and posterior borders; the center of the shell has what the silversmiths would call a "satin finish."

Length, 52.00; height, 37.00; breadth, 23.00 mill. ♂ (7502).
" 60.00; " 45.00; " 30.00 " ♀ (7503).
" 43.00; " 32.00; " 20.00 " ♀ (7501).

Animal: Anal opening rather large, with dark papillæ; branchial opening large, with coarse, dark papillæ; mantle border greatly thickened and dentate below; inner gill much the larger in front, united to the abdominal sac throughout; marsupium occupying the posterior half of the outer gill of the female, ovisacs large, dark below. (Simpson.)

Distribution: Mississippi and Ohio valleys and Lake Michigan.

Geological distribution: Pleistocene.

Habitat: Same as *L. iris.*

Remarks: A species at once distinguished by its subovate outline, inflated beaks and numerous rays, which radiate from the umbones to the ventral and lateral margins. The umbonal markings are very distinct and peculiar, and the wavy character of the rays is not found in any other species which inhabit this area. It seems to be confined to the lakes in the southern region.

SECTION METAPTERA Rafinesque.

GROUP OF LAMPSILIS ALATUS.

28. **Lampsilis alatus** Say, pl. xviii.
Unio alatus SAY, Nich. Encyc. Vol. IV., fig. 2, 1816.

Shell: Large, rather solid, symphynote, broadly oval in outline in old specimens but obtusely triangular in strongly alate forms, somewhat inflated when adult but compressed when young, rounded before and generally very broadly rounded behind, although some specimens are triangulate; umbonal slopes rounded; the alate postero-dorsal margin is very much compressed, and when perfect is exactly triangular in shape, extending from the umbones to the posterior end of the shell; in old specimens, or those in which the "wing" is not fully developed, the shape is not so clearly defined; ventral margin slightly rounded; surface smooth and shining on the central part of the shell, with the lines of growth large and coarse on the anterior, posterior and ventral margins and the alate portions; epidermis black or greenish black, in the young yellowish horn, perfectly plain and rayless in old specimens but distinctly rayed with numerous fine green rays over a yellowish background in young and half grown specimens; umbones depressed, flush with the hinge line, ornamented by several very fine raised ridges; ligament large, solid, light brown in color; cardinal teeth double in both valves, those in the left valve about equal in size, long and narrow, elevated, strongly grooved on their anterior faces; those in the right valve unequal in size, the anterior tooth small, the posterior tooth large and similar in form to those of the left valve; lateral teeth long, thin, lamellar, elevated, very slightly arcuate, smooth; anterior adductor muscle scar deeply impressed, striated; posterior adductor muscle scar large, very indistinct, confluent; *protractor pedis* muscle scar deeply impressed, striated; pallial line distinct, impressed, somewhat crenulated; dorsal muscle scars in the cavity of the beaks and arranged in nearly a straight row, deeply pitted; there are from six to seven small, rounded pits, followed by a single long and narrow scar very deeply impressed; cavity of the beak wide, shallow; nacre varying from deep purple, through mauve to salmon pink, iridescent.

Length, 114.00; height, 74.00; breadth, 36.00 mill.
" 121.00; " 92.00; " 37.00 "
" 68.00; " 59.00; " 19.00 "

Animal: Anal opening small, without papillæ; branchial opening small with vestiges of papillæ; palpi subtriangular, united only slightly behind; inner gill united throughout to abdominal sac; branchial uterus occupying posterior part of the outer gill, very distinct, projecting below inner gill. (Simpson).

Distribution: Western New York west to Nebraska and Iowa, Wisconsin south to New Mexico.

Geological distribution: Pleistocene.

Habitat: In the larger lakes and rivers, on a muddy bottom, in water from five to twenty feet in depth.

Remarks: Alatus is a very distinct species, easily known by its rich purple interior and very alate postero-dorsal margin. The latter is more pronounced in young than in old specimens, the latter becoming more oval in form and losing to some degree their pronounced alate character. The division between the posterior umbonal slope and the alate "wing" is marked by an area of the lines of growth which is raised in strong, wavy ridges. The rays vary to some extent, the young shell having rather wide green rays on a yellowish background; half-grown specimens have narrow rays on a yellowish green background, while old specimens have a perfectly rayless epidermis. The cardinal teeth also vary in some specimens, being rather long and narrow, with sulcations on the anterior faces, while in others they are more solid, wider, long, triangular, and the sulcations are extended to the upper surface of the teeth, which are all directed toward the antero-ventral border of the shell. The anterior adductor muscle scar almost always has a heavy ridge between it and the *protractor pedis* scar, the ridge bearing a portion of the adductor scar. The alate portion of the shell extends far above the lateral teeth. This species has been found in the southern region in the Calumet River, and in the western region in the Desplaines River. It does not appear to be common.

29. **Lampsilis gracilis** Barnes, pl. xix., fig. 1.

Unio gracilis Barnes, Amer. Journ. of Sci. and Arts, 1st series, Vol. VI., p. 274, 1823.

Unio fragilis Raf., Conrad, Mon., pl. xxx., 1836.

Unio dolosus Lea, Journ. Phil. Acad., Vol. V., p. 75, pl. ix., fig. 224, 1861.

Shell: Elliptical, compressed, alate, rather thin, rounded before and very broadly rounded behind (sometimes obtusely triangular); dorsal margin straight, ventral margin rounded; dorsal margin alate posteriorly and the shell produced postero-ventrally; surface generally smooth and shining, the growth lines very faint, excepting on the alate portion; in old specimens the growth lines are more prominent; umbones very much depressed, light or dark horn color, marked by four wrinkles arranged in a double loop; in older specimens the umbones become almost smooth or are eroded; anterior umbonal slope almost flat, posterior slope long, subexcavated; ligament weak, long and narrow, very dark horn color; epidermis yellowish, with numerous grass green rays extending diagonally from the umbones to the base and posterior end; some specimens are plain yellow or yellowish horn; cardinal teeth weak, very thin, elevated, striated on the inner face, single in each valve, that in the right valve much the larger; lateral teeth more solid than cardinals, long, lamellar, elevated, minutely striated, very slightly curved; no connecting plate between cardinal and lateral teeth; anterior adductor muscle scar longer than wide, impressed, striated; posterior adductor muscle scar very wide, not much impressed, confluent; *protractor pedis* muscle scar wider than long, impressed, striated; dorsal muscle scars arranged in almost a straight line under the cavity of the beaks, six to eleven in number in each valve, rather heavily impressed; cavity of the beaks very shallow; pallial line more or less distinct; nacre silvery white, salmon tinged in the center of the shell, more or less iridescent.

Length, 124.00; height, 78.00; breadth, 41.00 mill. (coll. Jensen).
" 88.00; " 61.00; " 26.00 " (12945).

Animal: Edges of anal opening very much thickened, without papillæ; branchial opening small, with large, irregular papillæ; mantle greatly thickened on its lower edge; palpi long, elliptical, united over half way behind; inner gill much the larger, rounded below, united the whole length of the abdominal sac; marsupium enormous, with forty ovisacs, occupying the posterior three-fifths of the outer gill. (Simpson.)

Distribution: Ottawa River, Canada, to Minnesota, Iowa and Kansas, and south to Central Alabama and Texas. (Call.)

Geological distribution: Pleistocene.

Habitat: Found in rivers and sloughs where there is a muddy bottom and not much current.

Remarks: This is a distinct shell and is quite readily identified. Its peculiar yellow surface, with green rays (sometimes pure yellow, without rays), its depressed umbones and its alate postero-dorsal margin will at once distinguish it. It may be distinguished from *L. alatus* by its yellowish color, weak teeth and thinner shell. Very old specimens lose the alate character and become broadly elliptical in outline, and some specimens have the posterior end very much produced. The very weak hinge teeth allies this species to the members of the genus *Alasmodonta*, and under very favorable conditions it might become, by living in a quiet, muddy pond, an *Anodonta* by the atrophy of the teeth. In some individuals the cardinal teeth are so small that they appear as simple nodules. The position of the *protractor pedis* muscle scar is quite peculiar. The species does not appear to be very common, but is rather widely distributed. A specimen from Thorn Creek weighed one pound and one ounce when alive. (*Vide* Jensen.)

SECTION EURYMA Rafinesque, 1820.

GROUP OF LAMPSILIS ANODONTOIDES.

30. **Lampsilis anodontoides** Lea, pl. x., figs. 1, 2, 3.

Unio anodontoides Lea, Trans. Amer. Phil. Soc., Vol. IV., pp. 81, 89, pl. viii., fig. 11, 1830.

Unio teres Rafinesque, *vide* Conrad's monograph, pl. xxviii.

Unio floridensis Lea, Trans. Amer. Phil. Soc., Vol. X, p. 274, pl. xxi., fig. 31, 1852.

Shell: Solid, very long, somewhat inflated, rounded before and acutely pointed behind, the female much swollen and produced in this region; dorsal and ventral margins about straight; surface smooth and shining, frequently highly polished; umbones placed anteriorly, prominent but not much elevated, marked by from five to seven scarcely elevated wrinkles arranged in a long double loop; ligament elevated, strong, wide, dark chestnut color; epidermis varying from plain yellow without rays to light green with dark green rays; in some specimens the posterior umbonal slope is painted with dark green; anterior umbonal slope rounded, short; posterior slope long, slightly excavated; cardinal teeth double in both valves, elevated, long and narrow, compressed, serrated; lateral teeth very long, lamelliform, elevated, striated; connecting bridge between cardinals and laterals narrow, thin; anterior adductor muscle scar as wide as high, deeply impressed, striated, confluent; posterior adductor muscle scar wide, distinct, confluent; *protractor pedis* muscle scar long and narrow, deeply impressed; dorsal muscle scars numerous, deeply impressed, situated in the cavity of the beaks; pallial line impressed; cavity of the beaks shallow; nacre silvery white, pearly and iridescent.

Length, 79.00; height, 32.00; breadth, 26.00 mill. ♂ (12442).
" 78.00; " 35.00; " 27.00 " ♀ (12442).

Animal: Anal opening small, with many light brown papillæ; branchial opening small, papillose; palpi large, subtriangular, united half way posteriorly; branchiæ very long, curved below, inner the larger, united the whole of its length to the abdominal sac; posterior half of the outer gill of female used as a marsupium, composed of large ovisacs with rounded bases which are stained black. (Simpson.)

Distribution: New York to Kansas, Minnesota to Texas, Alabama and Florida.

Geological distribution: Pleistocene.

Habitat: Prefers a muddy bottom where it can bury itself. Found in rather deep water, generally.

Remarks: Anodontoides is frequently confounded with *luteolus*, but may be distinguished by the following characteristics: *Luteolus* is never so sharply pointed posteriorly, but is rounded; the shell of the present species is longer compared with its height than is *luteolus;* the female of the *luteolus* is much more swollen posteriorly than is that of *anodontoides.* The present species is not as widely distributed throughout the region under consideration as *luteolus*, and the individuals are not so numerous. The Desplaines River and its tributaries is the only stream, so far as known, in which this species is found. The epidermis varies from a perfectly plain yellow to yellowish green, rayed with dark green. Thus far it has only been found in the western region.

31. **Lampsilis rectus** Lamarck, pl. xvii., figs. 1, 2.

Unio rectus Lam., Hist. Nat. des Anim. sans Vert., Vol. VI., p. 74, 1819.
Unio prælongus Barnes, Amer. Jour. Sci. and Arts, 1st series, Vol. VI., p. 261, fig. 11, 1823.
Unio sageri Conrad, Monograph of Unio, p. 53, pl. xxix., 1836.
Unio leprosus Miles, Ann. Rep. Geol. Surv. Michigan, p. 240, 1861.

Shell: Large, elongated, compressed, thick and heavy, rounded before, pointed-triangular behind; dorsal margin nearly straight; ventral margin slightly rounded, much produced posteriorly in the female; surface smooth and shining, growth lines well marked, imbricated on the lower half of the shell and more or less on the anterior and posterior ends; umbones depressed, inflated, brownish, rather small, marked by numerous fine ridges; anterior umbonal slope rounded; posterior slope rounded near the posterior part of the shell, but more or less angular near the umbones; ligament long, wide, stout, very dark brown or black; epidermis corneous or blackish, with a reddish tinge, obscurely rayed with broad, dark green bands of color, which disappear in old specimens; cardinal teeth double in both valves, those in the left valve about equal in size, the anterior tooth in the right valve generally very small, but by an enlargement of the hinge line, sometimes quite large and elevated; teeth generally posteriorly recurved and erect, stout, triangular and heavily serrated, sometimes thin, sharp, very much elevated and serrated; lateral teeth long, straight, lamelliform, elevated, crenulated; anterior adductor muscle scar wing shaped, longer than wide, very deeply excavated, striated; posterior adductor muscle scar rounded, diameters equal, generally, distinct but hardly impressed, concentrically striated; *protractor pedis* muscle scar wider than long, very deeply impressed, striated; pallial line crenulated, deeply impressed anteriorly; dorsal muscle scars situated in the center of the cavity of the beaks, large, oval, forming deep pits; cavity of the beaks very shallow; nacre silvery white or dark purple, and exhibiting all variations between these two colors; some specimens are white about the ventral and anterior and posterior portions, and deep purple or pink in the region beneath the hinge teeth.

Length, 106.00; height, 45.00; breadth, 27.00 mill. ♂ (9718).
" 116.00; " 53.00; " 33.00 " ♂ (12440).

Animal: Anal opening small, without papillæ; branchial opening moderate, with many irregular papillæ; mantle edge thick and doubled; outer edge plain, inner with beautiful regular teeth on posterior half; inner gill the larger, united nearly the whole length to abdominal sac; branchial uterus occupying position two-fifths of outer branchiæ in thirty-two distinct ovisacs. (Simpson.)

Distribution: New York west to Nebraska, Michigan south to Texas and Georgia.

Geological distribution: Pleistocene.

Habitat: In lakes or rivers of considerable size, on a muddy bottom, in from five to twenty feet of water.

Remarks: A very distinct species, which can be confounded with no other; the females have the postero-ventral portion very much produced. It is one of the heaviest species we have. The nacre of the shell is the most beautiful of any of our species, varying from pure white to deep purple. It is confined to the southern and western regions.

GROUP OF LAMPSILIS LUTEOLUS.

32. **Lampsilis luteolus** Lamarck, pl. xi.; pl. xxvii., fig. 12.

Unio luteolus LAM., Animaux sans Vertebres, Vol. VI., p. 79, 1818.
Unio siliquoideus BARNES, Amer. Jour. Sci. and Arts, 1st series, Vol. VI., p. 269, fig. 15, 1823.
Unio inflatus BARNES, Amer. Jour. Sci. and Arts, Vol. VI., p. 266, 1823.
Unio approximus LEA, Trans. Amer. Phil. Soc., Vol. X., p. 74, pl. v., fig. 13, 1848.
Unio affinis LEA, Trans. Amer. Phil. Soc., Vol. X., p. 271, pl. xix., fig. 26, 1852.
Unio distans ANTHONY, Amer. Journ. of Conch., Vol. I., p. 156, 1865.

Shell: Large, elliptical, thin or very thick, more or less inflated, symmetrically rounded before and elongately oval behind, the female generally very obtuse; dorsal margin straight; ventral margin very slightly curved in the male and much produced in the female; surface smooth and polished in some specimens, roughened by growth lines in others; umbones prominent, inflated, but not much elevated, brownish or greenish in color, generally eroded, and marked by about fourteen fine, undulating, elevated ridges, the apex directed anteriorly; ligament short, rather wide, stout, dark chestnut color; epidermis varying from light, yellowish green to dark horn color or dark green, and generally with numerous dark green rays, which radiate from the umbones; the rays may be straight or crenulated and vary in width from 0.25 to 2.00 mill.; in old specimens the rays may be few in number, indistinct or wanting; anterior umbonal slope gracefully rounded, posterior long and flat, or slightly excavated; cardinal teeth double in both valves; left anterior cardinal elevated, tooth-like, striated, right posterior long and narrow, not so much elevated, striated; right anterior cardinal very small, posterior large, elevated, pyramidal, coarsely striated and notched; laterals long and narrow, elevated, striated; anterior adductor muscle scar excavated, longer than wide, coarsely striated; posterior adductor muscle scar as long as wide, large, not very deeply impressed, more or less confluent; *protractor pedis* muscle scar wider than long, deeply impressed and marked by strong crenulations; dorsal muscle scars numerous, situated in the cavity of the beaks, the posterior scars the larger, all very deeply excavated; pallial line well marked; cavity of the beaks shallow; nacre white, more or less iridescent.

Length,	116.00;	height,	63.00;	breadth,	48.00	mill.	♀	(9295).
"	115.00;	"	56.00;	"	42.00	"	♀	(9294).
"	81.00;	"	43.00;	"	41.00	"	♂	(10360).
"	85.00;	"	47.00;	"	33.00	"	♀	(8053).
"	61.00;	"	39.00;	"	26.00	"	♂	(9631).

Animal: General color whitish or cream, tentacular portion of mantle brownish; anal opening small, without papillæ; branchial opening larger with numerous papillæ; labial palpi large, cream colored, triangular, almost as broad as long, united at base and for a short distance along the superior border; ctenidia large, the outer one the smaller, rounded, united above, color pearly white; foot large, white, plough shaped; liver brown; gills of the female darker than the male. The heart may be seen very plainly through the transparent walls of the pericardium; the pulsations are wave-like, regular and number sixteen per minute. The posterior part of the outer gill is used as a marsupium.

Distribution: British America, from Great Slave Lake south to Texas; New York west to Montana and Dakota.

Geological distribution: Pleistocene.

Habitat: Found plentifully in the larger lakes and rivers, on a muddy bottom. In the DuPage River the specimens are found in a black, sticky mud, in a few feet of water.

Remarks: This species is subject to very great variation, as the synonymy shows. In the sets before me, representing every portion of the area, there are specimens running from bright green, beautifully rayed, to dark brown with scarcely an indication of rays. They vary in shape from short oval to a long ellipse. In thickness the variation is also great, those individuals found in Lake Michigan being much more ponderous than those from the smaller lakes and rivers. This variation is due to the fact that Lake Michigan specimens are subject to rough handling by the waves while those inhabiting the smaller lakes and rivers are more or less protected from wave action. Specimens from Wolf Lake are generally small, rather thin and delicately and beautifully rayed. Specimens from Lisle, DuPage River are more compressed and higher in relation to length than are the specimens, generally, from other regions. The present species is frequently confounded with *anodontoides*, but is quite distinct from that species.

Specimens collected July 25, 1896, contained embryos in the posterior third of the outer ctenidium measuring one-fifth of a mill. in diameter. The ctenidia at this time were much swollen and the embryos very numerous. The species in captivity is remarkably active, ploughing its way through the sandy or muddy bottom with considerable speed. The writer has noticed that the excurrent siphon continually opens and closes, and at each closing a current of water filled with fœtid matter is ejected. This operation is repeated on an average of twelve times in a minute.

GROUP OF LAMPSILIS IRIS.

33. **Lampsilis iris** Lea, pl. xiii., fig. 1; pl. xiv., fig. 2.

Unio iris LEA, Trans. Amer. Phil. Soc., Vol. III., pp. 409, 411, 421, 439, pl. xi., fig. 18, 1829.

Unio novi-eboraci LEA, Trans. Amer. Phil. Soc., Vol. VI., pp. 127, 147, 1838. Journ. Phil. Acad., Vol. IV., p. 47, pl. v., fig. 14, 1858.

Shell: Rather small, stout, compressed, elliptical, rounded before, triangular behind in the male and broadly rounded in the female; dorsal margin nearly straight, ventral margin rounded; surface smooth and polished, marked by distinct lines of growth; umbones depressed, compressed, the apex directed anteriorly, dark reddish brown, marked by five elevated ridges which are more or less broken up into nodules; anterior umbonal slope short and rounded; posterior slope long, flat, forming an obtuse angle; ligament long, narrow, stout, dark horn colored; epidermis yellowish or yellowish green, with numerous wide, interrupted dark green rays extending from the umbones to the ventral margin; cardinal teeth double in both valves, about equal in the left; the anterior teeth in the right valve very small, all elevated, triangular, serrated and striated; lateral teeth long, thin, lamellar, striated, almost straight; anterior adductor muscle scar much longer than wide, deeply excavated, striated; posterior adductor muscle scar large, as wide as high, faintly marked, confluent; *protractor pedis* muscle scar wider than high, deeply impressed, striated; dorsal muscle scars situated in the cavity of the beaks, large, deeply excavated; pallial line impressed; cavity of the beaks shallow; nacre pearly white, iridescent, especially on the posterior part.

Length, 57.00; height, 30.00; breadth, 20.00 mill. (7386).
" 55.50; " 30.00; " 20.00 " (7385).
" 43.00; " 23.00; " 15.00 " (7384).

Animal: Generally whitish, inclining to flesh color; anal opening rather small, not provided with papillæ; branchial large, papillose; mantle yellowish or flesh colored, edged with brown; ctenidia short and wide, elongately rounded behind and obtusely rounded before, the inner gill the larger, united above throughout their entire length; foot long and tongue shaped, muscular; labial palpi tongue shaped, small, yellowish, united at base; abdomen yellowish; siphons brownish; heart pulsations fourteen, regular. The posterior part of the outer branchium is modified to form a marsupium.

Distribution: New York west to Illinois, Michigan south to Louisiana and Texas.

Geological distribution: Pleistocene.

Habitat: Found in lakes and rivers, in a few feet of water, on a sandy or muddy bottom.

Remarks: A distinct little species, distinguished by the interrupted rays, which appear to be concentric lines of square dots in some specimens. In a few specimens examined the rays were not broken, but were entire and gradually increasing in width as they neared the ventral border. This is one of the most common species found in this area, and also one of the most beautiful. It is widely distributed.

34. **Lampsilis spatulatus** Lea, pl. x., fig. 5; pl. xiii., fig. 2.

Unio spatulatus Lea, Trans. Amer. Phil. Soc., Vol. X, p. 80, pl. viii., fig. 22, 1845.

Shell: Elliptical, compressed, thick and heavy, rounded before, triangular behind; dorsal and ventral borders curved; surface roughened by the lines of growth which form scales on the ventral border; umbones depressed, inflated, light brown in color, marked by seven or eight delicate, wavy ridges; anterior umbonal slope rounded; posterior slope long and almost flat, slightly angled; ligament short, wide, stout, very dark chestnut; epidermis dark yellowish brown, or greenish yellow, marked with rather wide, uninterrupted dark green rays, which are more distinct on the center of the shell than elsewhere; cardinal teeth double in both valves, equal in the left and the anterior tooth very small in the right, thick, solid, triangular, deeply serrated; lateral teeth rather short, thick, solid, not much elevated, almost smooth, the lateral in the right valve very wide at the base and rapidly coming to a point; connecting plate very thin and narrow; anterior adductor muscle scar very deeply excavated, longer than wide, coarsely striated; posterior adductor muscle scar rounded, length and breadth equal, deeply impressed, striated; *protractor pedis* muscle scar wider than long, deeply excavated, striated; dorsal muscle scars situated on the posterior face of the cardinal teeth and on the wall of the cavity of the beaks, numerous, very deeply pitted; pallial line deeply impressed, especially on the anterior end; cavity of the beaks very shallow; nacre silvery white, iridescent, particularly on the posterior portion of the shell.

Length, 82.00; height, 46.00; breadth, 28.50 mill. (9840).
" 61.00; " 39.00; " 22.00 " (9840).
" 65.50; " 35.00; " 20.00 " (12419).

Animal: Generally flesh colored; anal opening small, without papillæ; branchial opening rather large, papillose; ctenidia not large, wide, rounded before, pointed behind, yellowish brown in color, united above for their whole length; labial palpi not large, rounded, triangular, yellowish white, united at base; siphons yellowish white inside, edged with a wide line of brownish black; mantle whitish or brownish, edged with black; liver dark brown; foot yellowish brown or dark flesh color; abdomen pearly white, flecked with pure white near the dorsal border. The posterior part of the outer branchium is used as a marsupium. Heart regular, sixteen beats per minute.

Distribution: Mississippi Valley.

Geological distribution: Pleistocene.

Habitat: Ponds and rivers, buried in black, slimy mud to a depth of four or five inches.

Remarks: Spatulatus is not a common species and has only been found in the DuPage River and Hickory Creek. It is frequently confounded with *iris*, but that species is almost always marked by interrupted rays while in *spatulatus* the rays are plain and uninterrupted; it is also larger and heavier than *iris*, and the posterior end is more pointed. It seems to be confined to the Desplaines River drainage.

GROUP OF LAMPSILIS LIGAMENTINUS.

35. **Lampsilis ligamentinus** Lamarck, pl. xvi.

Unio ligamentina LAM., Animaux sans Vertebres, Vol. VI., p. 72, 1819.

Unio ligamentinus LAM., Animaux sans Vertebres, Vol. VI., p. 533, 1838.

Unio crassus SAY, Nich. Encyc., Amer. Ed., Art. Conch., pl. i., fig. 8, 1816.

Unio carinatus BARNES, Amer. Journ. Sci. and Arts, 1st series, Vol. VI., pp. 126-259, pl. ii., fig 10, 1823.

Unio ellipticus BARNES, Amer. Journ. Sci. and Arts, 1st series, Vol. VI., pl. xiii., fig. 19, 1823.

Unio fasciatus RAFINESQUE, Conrad, Monograph of Unio, p. 3, pl. i., 1836.

Unio upsoni MARSH, Mss. *vide* CALL, Trans. Acad. Sci., St. Louis, Vol. VII., p. 23, 1895.

Shell: Large, compressed, thick and heavy, elliptical, rounded before and biangulate behind; dorsal and ventral margins rounded; surface smooth and shining in the young and with raised line of growth in old specimens; the shell is much thicker anteriorly than posteriorly; umbones not prominent, a little swollen, brownish in color, and marked by seven or eight fine, undulating, concentric folds; in old specimens the umbones are eroded; anterior umbonal slope rounded, posterior slope forming an angle; ligament rather long, thick, very dark chestnut color; epidermis yellowish or light greenish with numerous dark green rays extending from the umbones to the ventral border; old specimens are very dark; the rays vary in width from very narrow to broad stripes; cardinal teeth double in both valves, those in the left valve about equal, triangular, crenulated; the anterior cardinal in the right valve very small, the posterior large, triangular, crenulated; lateral teeth strong, heavy, elevated, lamellar, crenulated, curved toward the ventral margin; connecting plate smooth, arched, rather thick; anterior adductor muscle scar deeply excavated, a trifle longer than wide, strongly striated; posterior adductor muscle scar as wide as long, lightly impressed, confluent; *protractor pedis* scar wider than long, deeply impressed, striated; dorsal muscle scars situated on the posterior face of the cardinal teeth and connecting bridge, numerous, large, deeply impressed; pallial line wide, impressed; cavity of the beaks of medium depth; nacre white, varying to bluish and pinkish, iridescent.

Length, 72.00; height, 41.50; breadth, 23.00 mill. (12442).
" 98.00; " 58.00; " 35.00 " (12423, Kankakee River).

Animal: Anal opening large with an irregular crenulated edge; branchial opening large with many small brown papillæ; palpi small, subelliptical, united one-third of the way posteriorly;

branchiæ very large, nearly circular below, inner larger, united to abdominal sac or free; marsupium occupying two-thirds of the posterior part of outer branchiæ, greatly distended. (Simpson.)

Distribution: New York to Dakota and Kansas, Michigan and Minnesota to Louisiana and Alabama.

Geological distribution: Pleistocene.

Habitat: Found in muddy and sluggish rivers, in soft mud.

Remarks: This is a variable species which is frequently confounded with *luteolus*. It is a more elliptical shell in general, but the ornamentation of the umbones shows the greatest difference; in *luteolus* they are of good size, numerous and wavy, while in *ligamentinus* they are small and few in number. The nacre is very variable, passing from pure white, through bluish white, to pinkish. The epidermis of the present species varies somewhat, some specimens being yellowish with wide dark green rays, while other specimens are almost black, the rays being represented only by darker bands. When at its best, it is one of our most beautiful shells. It seems to be confined to the Desplaines River drainage.

SECTION CORUNCULINA Simpson.

GROUP OF LAMPSILIS PARVUS

36. **Lampsilis parvus** Barnes, pl. xiii., fig. 3.

Unio parvus BARNES, Amer. Jour. Sci. and Arts, 1st series, Vol. VI., p. 274, fig. 18, 1823.

Shell: Small, thin, inflated, elliptical, rounded before and behind; dorsal border straight, ventral border very slightly rounded; surface roughened by coarse lines of growth which are more or less elevated; umbones large for the size of the shell, not elevated, inflated, yellowish brown in color, marked by five or six elevated, strong, parallel curved ridges, which are nearer the hinge line posteriorly than anteriorly; anterior umbonal slope rounded, posterior slope rounded or with a slight angle, excavated near the beaks; ligament long, narrow, fragile, dark horn color; epidermis blackish or olive green, sometimes with a golden luster, rayless; cardinal teeth small, single in the right and double in the left valve, erect, thin, acuminate, serrated, widely separated; there is sometimes a second very small tooth in the right valve, near the hinge line; lateral teeth long, slightly striate, smooth, lamellar; anterior adductor muscle scar forming a truncated oval, impressed; posterior adductor muscle scar roundly ovate, scarcely impressed, confluent; *protractor pedis* muscle scar small, wider than long, deeply impressed; dorsal muscle scars minute, placed in the cavity of the beaks (which are large but not deep), deeply impressed; pallial line distinct, impressed anteriorly; nacre pearly or silvery white, iridescent, especially posteriorly.

Length, 21.00; height, 12.00; breadth, 8.50 mill. ♂ (10084).
" 21.00; " 12.50; " 9.00 " ♂ (10084).
" 30.00; " 14.00; " 12.00 " ♂ (12415).

Animal: Generally whitish or yellowish white in color; ctenidia not large, rounded at both ends, united above throughout their entire length, pearly white in color, with a line of yellowish at their junction; the posterior extremity is thicker than the anterior; labial palpi rather large, whitish flecked with yellowish, triangular, united at base and partly on the posterior margin; anal and branchial openings rather large, edged with dark brown; the female is provided with a caruncle supported by a pedicel; mantle edged with black; foot large, pointed; abdomen yellowish white; liver greenish brown; heart pulsations regular, thirty-six per minute; this is the largest number of pulsations for the genus. Posterior part of outer gill used as a marsupium.

Distribution: Minnesota south to Texas, Western New York west to Iowa.

Geological distribution: Pleistocene.

Habitat: Found buried in soft mud to a depth of from an inch to six or seven inches. It prefers slow moving streams, where there is a muddy bottom.

Remarks: This is the smallest *Unio* found in our region. The female is distinguished from the male by a pronounced swelling in the posterior portion. It is interesting to watch this tiny species moving about the bottom of an aquarium; it will lie for a long time on the bottom, its siphons extended to their full length, a current of water continually flowing from the excurrent siphon; if it desires to move, the long and finger like foot will be cautiously thrust out, extended its full length, and the shell pulled after it with a jerk. The umbonal sculpture is the coarsest of any Unio in this region, in proportion to the size of the shell. The young sometimes have one or two broad green bands, but the adult is completely rayless. The species is confined to the Desplaines River drainage.

ORDER TELEODESMACEA.

"Pelecypods with reticulate gills, the ventricle of the heart embracing the rectum; having the lobes of the mantle generally more or less connected and usually possessing developed siphons; the adductors practically equal; the shell structure cellulo-crystalline (porcellanous) or obscurely prismatic, never nacreous; the dorsal area, if present, always prosodetic or divided into lunule and escutcheon; ligament opisthodetic, with or without separate resilium; without a lithodesma, rarely with external accessory shelly pieces; armature of the hinge characterized by the separation of the hinge teeth into distinct cardinals and laterals, the posterior laterals when present are behind the ligament; the animals active or nestling, sometimes sessile, but rarely sedentary burrowers, rarely inequivalve, usually possessing a hinge plate and a pallial sinus. The sexes usually separate." (Dall.)

Superfamily Cyrenacea.

"Cypricardians which have become specialized for fresh or brackish water conditions, and, as usual in such cases, have developed great variability of character." (Dall.)

FAMILY SPHÆRIIDÆ.*

"Anatomy much as in *Cyrenidæ*, except that the siphons are separate and plain, the branchial sometimes not complete below; the foot prolonged ventrally, narrow, grooved, byssiferous when young; monœcious, the nepionic young incubated in a marsupium formed by the inner limb of the ctenidia; confined to fresh water.

"Shell as in *Cyrenidæ*, but small, with a feeble, short ligament, a simple pallial line, no hinge plate; the cardinal teeth (usually two in each valve) variable, very thin, often nearly parallel to the hinge-margin or defective in part of the series; the laterals in *Cyrenidæ* distinct; the nepionic stage of the shell often conspicuous on the beaks." (Dall.)

GENUS **SPHÆRIUM** Scopoli, 1777.

Sphærium SCOPOLI, Introduct. ad Hist. Nat., p. 397, 1777.
Cyclas BRUGUIERE, Encyc. Méth., p. 301, 1792.

"*Shell:* Thin, oval or suborbicular, inflated, covered by a greenish epidermis; cardinal teeth very small or rudimentary, one more or less bifurcated, one in the right and two oblique ones in the left valve; lateral teeth compressed, lamelliform, the anterior shortest; ligament short; margins plain; muscular impressions scarcely apparent, submarginal; pallial impression simple.

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*Dall, Trans. Wagn. Free Institute of Sci., Vol. III., pt. iii., p. 540.

"*Animal:* Oval, subglobular; mantle margins plain; siphons unequal, not ciliated, short, only united at the base, the branchial one largest and longest; mouth small, oval, transverse; branchiæ large, unequal, united behind, the inner ones largest; foot tongue shaped, triangular, flattened, very extensible." (Tryon.)*†

"Posterior part of shell somewhat longer than anterior; shell and hinge comparatively stout; beaks rounded without caps." (Sterki, in lit.)

The cardinal teeth of *Sphærium* (Fig. 10A) are very interesting, and, generally, quite constant in form. In the right valve there is a single, arched tooth, which is placed so that one end of the arch is near the dorsal margin of the hinge plate, and the other, somewhat bulb shaped, is near the ventral margin. This tooth fits in between two peculiar teeth in the left valve. One tooth (the upper) extends from the dorsal margin, in a slight curve to the center of the hinge plate. The tooth is narrow and elevated. Near the ventral margin is placed the second tooth, which is elevated, pyramidal and larger than the upper one. The lateral teeth are placed on either side of the cardinal in each valve, two teeth (single) being in the left valve and four

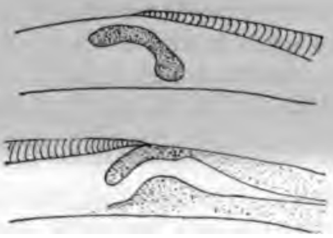

FIG. 10A.

Cardinal Teeth of SPHÆRIUM STRIATINUM Lam. (x 50). Upper figure, right valve; lower figure, left valve.

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*Structural and Systematic Conchology, Vol. III., p. 186.

†For a good account of the anatomy of Sphærium see Proc. Iowa Acad. of Sci., Vol. III., p. 173, 1895, a paper by Mr. Gilman A. Drew.

(double) teeth in the right valve. They are generally long, lamellar and elevated, and either straight or curved.

Distribution: North and South America, Europe, Oceanica, Asia, Africa, New Zealand, East Indies and Madagascar.

The young of both *Sphærium* and *Pisidium* are contained in the inner gill and are of gigantic size as compared with that of the parent, sometimes being one-sixth the length of the adult. When born they "are very active, climbing about submerged plants and often suspending themselves by byssal threads." (Tryon.) The genus is very plentifully distributed, the species being very numerous in individuals. The group is hermaphroditic.

KEY TO SPECIES OF SPHÆRIUM AND CALYCULINA.

A. Shell solid, epidermis dark.
  a. Umbones situated anterior of the center of the shell, giving it a transversely elongated outline.
    1. Shell trigonal, umbones elevated and inflated, almost smooth....... ....*solidulum*
    2. Shell oval, umbones not as much elevated as 1, very full, coarsely ridged..................*stamineum*
    3. Shell transversely elongated, umbones small, depressed, almost smooth....................*striatinum*
  b. Umbones situated near the center of the shell, depressed; shell transversely oval................. ....*simile*
B. Shell fragile, epidermis light.
  a. Shell transverse.
    1. Shell very transverse, umbones elevated and placed well toward the anterior end........*transversum*
    2. Shell transversely oval, umbones depressed and placed centrally..............................*fabale*
  b. Shell rhombic.
    1. Shell rhombic-ovate, posterior end squarely truncated, umbones placed near the center....*truncatum*
    2. Shell much inflated, rhombic-orbicular, posterior margin truncated, very high compared with the anterior margin, beaks a trifle anterior, subangulate................................*securum*
  c. Shell oval.
    1. Shell somewhat inflated, small, ends rounded...*occidentale*
    2. Shell compressed, large, posterior end truncated..................................*partumeium*

37. **Sphærium solidulum** Prime, pl. xxvii., fig. 4.
Cyclas solidula PRIME, Proc. Bost. Soc. H. N., Vol. IV., p. 158, 1851.
Cyclas distorta PRIME, l. c., p. 158, 1851.

Shell: Of good size, inflated, very solid, inequilateral, trigonal; umbones inflated, somewhat elevated, placed anterior to the center of the shell, marked by rather coarse ridges; dorsal margin strongly arcuate, ventral border rounded, posterior margin long, obtusely triangular, the umbonal slope rounded; anterior margin rounded; surface shining, growth lines coarse, crowded; fine lines may be seen between the coarse ones when viewed with a lens; color varying from dark horn to yellowish brown, sometimes marked by large blotches of both colors on the shell and with a yellowish line bordering the ventral margin; ligament thin, dark brown; cardinal teeth very small, a single lamellar, elevated tooth, which forms a long, arched projection beneath the point of the beak in the right valve, and two elevated, curved, thin teeth in the left valve, one just beneath the beak and one midway between hinge margins; the hinge line in both valves is thickened and extends from the lateral to the cardinal teeth, rising to meet the latter; lateral teeth situated on either side of the cardinals in each valve, short, elevated, thick, curved, double in the right and single in the left valve; muscle scars and pallial line distinct, the latter crenulated; nacre bluish white, darker near the cavity of the beaks, which are deep.

Length, 11.00; height, 8.75; breadth, 7.00 mill. (12458).

Animal: Not observed.

Distribution: New York to Iowa, Wisconsin to Louisiana and New Mexico.

Geological distribution: Pleistocene.

Habitat: Found in the smaller rivers and creeks, on a muddy bottom.

Remarks: This species is easily known by its strongly trigonal outline and solid shell. It is distinguished from *stamineum* by its less distinctly marked umbones and more trigonal form; *striatinum* is much more transverse and is very much more compressed, while the umbones are smaller, and the shell is smaller than *stamineum* generally. It does not seem to be a common shell, and is confined to the Desplaines River drainage and Lake Michigan.

38. **Sphærium stamineum** Conrad, pl. xxvii., fig. 1.

Cyclas staminea CONRAD, Amer. Jour. Sci. and Arts, 1st series, Vol. XXV., p. 342, pl. i., fig. 5, 1834.

Cyclas fuscata RAFINESQUE, PRIME, Proc. Bost. Soc. N. H., Vol. IV., p. 281, 1852.

Cyclas bulbosa ANTHONY, PRIME, l. c., p. 283, 1852.

Shell: Large, inflated, rather solid, inequilateral, oval; umbones depressed, inflated, placed anterior to the center of the shell, marked by a number of coarse, rounded, even ridges, which cause the beaks to stand out prominently; umbonal slopes rounded; dorsal margin slightly arched, ventral border rounded; anterior and posterior margins rounded or subtruncated; surface shining, marked by very strong lines of growth; color yellowish or brownish, sometimes dark horn color; ligament weak, dark horn color; cardinal teeth very small, a single, elevated arched tooth situated just beneath the beak, the two arches of unequal length, in the right valve, and two narrow, solid, elevated, pyramidal teeth which are placed as in *solidulum*, the tooth near the ventral border being smaller and more elevated, in the left valve; the hinge line is a trifle thickened; lateral teeth on each side of the cardinals short, thick, solid, elevated, serrated, double in the right and single in the left valve; muscle scars and pallial line faint; nacre bluish white, with zones of very dark purple or horn color.

Length, 14.00; height, 11.00; breadth, 9.00 mill. (9385).
" 10.50; " 8.00; " 5.50 " (8510).
" 10.50; " 9.00; " 7.00 " (9882).
" 9.00; " 8.00; " 5.50 " (8511).

Animal: Bluish or whitish, transparent, yellowish about the base of the siphons and brownish on the dorsal part near the liver and heart; mantle lobes thin and transparent, edged with brownish yellow or yellowish white, very muscular; siphons long, united only at base, ventral very large and longest, not ciliated; adductor muscles not large and rather weak; foot retractor and protractor muscle well developed; foot long and digitiform, transparent, and capable of extension more than the length of the shell; it is thrust from a cleft in the mantle about the center of the ventral border of the shell; ctenidia large, the outer the smallest, rounded before and behind, united above; labial palpi long and narrow, ciliated, united at base, bluish white in color; pericardium situated well on the dorsal surface; heart very plainly seen, beats regular, fifty-seven per minute.

Distribution: New England west to Arkansas and Iowa, Illinois south to Alabama and Louisiana.

Geological distribution: Pleistocene.

Habitat: In small creeks, ponds and rivers, buried in black, slimy mud to a depth of several inches.

Remarks: This is a common and widely diffused species, occurring in all parts of the area under discussion. Particularly large and fine specimens are found in the DuPage River near Lisle. Some little variation exists, principally in the relative length and height. It may easily be recognized by its inequilateral form and very heavily marked umbones.

On July 25, 1896, the writer found young in the inner gills, measuring from two to five or six millimeters in length, three or four being found in each gill. The animal is quite active, moving by a series of jerks. Progression is effected by means of the foot, which is thrust out to its fullest extent and the shell drawn after it. It is very interesting to watch this species in an aquarium and notice its quick, jerky motions. It thrives well in captivity, and is very well adapted for anatomical investigations, owing to its large size.

39. **Sphærium simile** Say, pl. xxvii., fig. 3.
Cyclas similis SAY, Nich. Encyc., Am. Ed., Vol. II., pl. i., fig. 9, 1817.
Cyclas sulcata LAMARCK, An. sans Vert., Vol. V., p. 560, 1818.
Cyclas Sarratogea LAMARCK, l. c., p. 560, 1818.
Cyclas lasmampsis RAFINESQUE, An. Gen. Sci. Phys. et Nat., Vol. V., p. 319, pl. lxxxii., figs. 19, 20, 1820.
Cyclas solida DEKAY, Moll. of N. Y., p. 229, pl. xxv. fig. 265, 1843.
Cyclas gigantea PRIME, Proc. Bost. Soc. N. H., Vol. IV., p. 157, 1851.
Cyclas ponderosa PRIME, l. c., p. 157, 1851.

Shell: Large, inflated, rather solid, almost equilateral, transversely oval; umbones depressed, inflated, placed a trifle anterior to the center of the shell, marked by heavy ridges, but not so coarse as in *stamineum;* dorsal margin very nearly straight, ventral border broadly curved; anterior and posterior margins almost equal, the posterior a little longer than the anterior, the two margins rounded; umbonal slopes rounded; surface shining, growth lines coarse; color dark brown, sometimes with a reddish tinge; ligament weak, very dark horn or black; cardinal teeth small, a single, long, stout, elevated, arched tooth in the right valve, and two stout, elevated teeth in the left valve, the upper tooth being short and curved and the lower tooth long and almost straight; one specimen (10882) seems to have the teeth in the right valve double and placed like those of the left valve; the teeth are sometimes very long and lamellar (8513); lateral teeth double in the right and single in the left valve, short, elevated, lamellar, nearly straight; muscle scars and pallial line faintly impressed; nacre bluish; cavity of the beaks shallow.

Length, 16.50; height, 11.75; breadth, 9.00 mill. (S513).
" 15.50; " 12.00; " 9.00 " (8513).
" 18.00; " 13.00; " 10.00 " (12460).

Animal: Not observed.

Distribution: United States and Southern Canada.

Geological distribution: Pleistocene.

Habitat: In rivers and lakes, in soft mud.

Remarks: The hinge teeth are arranged very peculiarly in this species, the laterals being in a direct line with the cardinals, and not at right angles to them, as in the previous species. It is one of the largest of the genus and distinguished from the related species by its transversely oval outline, its peculiarly placed teeth, and its umbonal marking, which is intermediate between *solidulum* and *stamineum*. The umbones are also placed very near the center of the shell. The species does not seem common, although found in the southern, northern and western regions, under circumstances which should be conducive to their multiplication.

40. **Sphærium striatinum** Lamarck, pl. xxvii., fig. 2.
Cyclas striatina LAM., An. sans Vert., Vol. V., p. 560, 1818.
Cyclas edentula SAY, New Harmony Dissem., p. 356, 1829.
Cyclas albula PRIME, Proc. Bost. Soc. N. H., Vol. IV., p. 155, 1851.
Cyclas tenuistriata PRIME, l. c., p. 156, 1851.
Cyclas acuminata PRIME, l. c., p. 158, 1851.
Cyclas inornata PRIME, l. c., p. 159, 1851.
Cyclas simplex PRIME, l. c., p. 159, 1851.
Cyclas modesta PRIME, l. c., p. 159, 1851.

Shell: Of medium size, not much inflated, solid, transversely elongated, very inequilateral; umbones depressed, full, placed anterior to the center of the shell, marked by numerous fine ridges, which are so fine in some specimens that the beaks appear smooth; dorsal margin arcuate; ventral margin rounded; posterior margin obtusely triangular; anterior margin broadly rounded; umbonal slope rounded, the posterior inclined to angular; surface shining, lines of growth coarse, but not so much so as in *stamineum*; color greenish yellow, varying to dark horn in some specimens; ligament weak, dark horn colored; cardinal teeth small, those in the left valve unequal, one placed near the dorsal margin of the hinge plate, small, and extending diagonally toward the ventral margin, and one placed near the ventral border of the hinge plate, large, pyramidal, elevated; that in the right valve arched, the left angle of the arch being shorter than the right, elevated, long, thick; lateral teeth double in the right and single in the left valve, short, elevated, stout, but slightly curved; muscle scars very faint; cavity of the beaks shallow; nacre bluish or whitish.

Length, 10.50; height, 7.50; breadth, 5.50 mill. (8510).
" 10 50; " 8.00; " 6.00 " (8510).
" 9.00; " 7.00; " 5.00 " (8514).

Animal: Not observed.

Distribution: New England west to California, Canada south to Louisiana, Alabama and Florida.

Geological distribution: Pleistocene.

Habitat: Same as for *stamineum.*

Remarks: This species is closely allied to *stamineum* but may be distinguished by its depressed beaks, more elongate outline and fainter growth lines, especially about the beak, which is very coarsely sulcated in *stamineum*. The species is as numerous in individuals as the latter species and resembles it also in habitat, burying to a considerable depth in the soft mud. It is universally distributed. It has been found fossil in a sand bank near the lake shore, east of Sheridan Drive and north of Graceland Avenue, by Mr. Jensen.

41. **Sphærium fabale** Prime, pl. xxvii., fig. 7.
Cyclas fabalis PRIME, Proc. Bost. Soc. N. H , Vol. IV., p. 159, 1851.
Cyclas castanea PRIME, l. c., Vol. IV., p. 160, 1851.
Cyclas sulculosa DE CHARPENTIER, MSS , 1851.

Shell: Of good size, transversely oval, somewhat compressed, almost equilateral, thin and fragile to quite solid; anterior and posterior margins rounded; ventral margin curved; dorsal margin slightly curved; umbones depressed, almost flush with the hinge line, placed near the center of the shell and quite heavily marked and regular; umbonal slopes gently rounded; surface smooth and shining in young or half grown specimens but dull in old examples; lines of growth typically very coarse and distinct, but finer in some specimens; color light green, yellowish or blackish, the latter a marked character in old specimens; ligament weak, color varying with the shell; cardinal teeth small, those in the left valve unequal, one placed near the dorsal margin and extending from the latter to a point midway between the dorsal and ventral margins of the hinge plate, and one placed near the ventral margin of the hinge plate; the dorsal tooth is nearly straight while the ventral tooth is very arcuate; in the right valve there is a single, large, arched tooth which extends from the center to the ventral border of the hinge plate, it is large at either end and small in the middle; lateral teeth double in the right and single in the left valve, rather small, elevated, pyramidal, slightly curved; hinge line rather solid; muscle scars indistinct; cavity of the beaks shallow; anterior bluish.

Length, 11.00; height, 9.00; breadth, 5.50 mill.
" 9.50; " 7.50; " 5.00 "
" 9.50; " 7.00; " 4.75 "

Animal: Not observed. Siphons said by Prime to be crimson.

Distribution: New England west to Iowa, Canada south to Louisiana.

Geological distribution: Pleistocene.

Habitat: In the large lakes, on a muddy bottom, in rather deep water.

Remarks: Fabale has been found at but one locality thus far, but probably occurs anywhere along the shore of Lake Michigan. Its only locality, Miller's, Ind., is at the extreme southern end of Lake Michigan. This interesting region is said by Prof. Garriott to be the most wind-swept locality in the Chicago area. This fact accounts for the enormous quantity of sea wrack which lines the shore at this point and which is not to be found in such profusion anywhere else along the shore. This sea wrack has proven prolific collecting ground for molluscan life.

The present species is very variable, running from perfectly smooth to coarsely striated and varying in color from yellow to black. It may always be known by its depressed umbones.

42. **Sphærium occidentale** Prime, pl. xxvii., fig. 10.

Cyclas ovalis Prime, Proc. Bost. Soc. N. H., Vol. IV., p. 276, 1852 (Preoccupied).

Sphærium occidentalis Prime, l. c., Vol. V., p. 122, 1855.

Shell: Small, inflated, fragile, equilateral; umbones prominent but not much elevated, inflated, placed centrally, marked by very fine lines; dorsal and ventral margins rounded; anterior and posterior margins rounded; umbonal slopes rounded; surface shining, marked by very fine lines of growth; color light horn, sometimes darker; ligament as usual; cardinal teeth small, a single, elevated, lamellar, curved tooth in the right valve, the posterior curve of which is longer than the anterior and is club shaped, and two teeth in the left valve, that near the ventral border of the hinge plate being elevated and pyramidal, that on the dorsal border being long, lamellar, depressed, and curved, as in the preceding species; lateral teeth short, elevated, curved, single in the left and double in the right valve; muscle scars scarcely discernible; cavity of the beaks shallow; nacre light purplish or bluish.

Length, 7.50; height, 7.00; breadth, 4.50 mill. (8456).
" 6.00; " 5.00; " 3.50 " (8456).

Animal: Transparent, whitish, reddish brown near the umbones; mantle white, thin and transparent; siphons of medium length, united at base; ctenidia large, wide, rounded, united above; labial palpi long and narrow, united at base; foot large, long and narrow, extended from the center of the shell; the shell is so transparent that most of the organs may be seen through it when held between the observer and the light.

Distribution: New England west to Washington, Canada south to Louisiana.

Geological distribution: Pleistocene.

Habitat: Found in lakes and rivers, in soft mud, either on the surface or buried.

Remarks: This species is distinguished by its oval outline, which is more regular than that of any other sphærium found here. It is very common, and when found at all is usually represented by hundreds of individuals.

GENUS CALYCULINA Clessin.

"Posterior part longer, or scarcely so, higher than anterior; shell very thin and fragile; hinge very fine." (Sterki in lit.)

43. **Calyculina transversa** Say, pl. xxvii., fig. 5.

Cyclas transversa SAY, New. Harm. Dissem , Vol. II., p. 356, 1829.
Cyclas detruncata PRIME, Proc. Bost. Soc. N. H., Vol. IV., p. 155, 1851.
Cyclas gracile PRIME, l. c., Vol. IV., p. 156, 1851.
Cyclas constricta ANTHONY, l. c., Vol. IV., p. 274, 1852.

Shell: Thin, of good size, inflated, inequilateral, transversely oblong, translucent; umbones elevated, not large, full, calyculate, placed anterior to the center of the shell, smooth and shining; dorsal margin straight; ventral margin broadly rounded; posterior margin subtruncated; anterior margin rounded; umbonal slopes rounded; surface smooth and shining, lines of growth very fine; color light yellowish, sometimes darker; ligament very thin, light brown; cardinal teeth small, a single, arched, elevated, lamellar tooth situated near the ventral margin of the hinge plate in the right valve; and two elevated teeth in the left valve, of which the dorsal is situated near the center of the hinge plate, arched, lamellar, and the ventral is situated near the lower margin of the hinge plate, and is elevated, pyramidal and solid; lateral teeth lamellar, straight, elevated, single in the left and double in the right valve; muscle scars very faint; cavity of the beaks shallow; nacre bluish white.

Length, 12.50; height, 9.00; breadth, 7.00 mill. (9965).
" 11.50; " 8.00; " 6.00 " (9965).

Animal: White, greenish about the liver; mantle lobes very thin and transparent; siphons rather short, narrow, about equal in size, united only at base, pinkish in color; foot very long and narrow, white, capable of great extension, and extended through a cleft in the mantle near the anterior end of the ventral portion; ctenidia large, white, rounded, united above; labial palpi long and narrow, united at base, white.

Distribution: New York west to Arkansas, Canada south to Alabama and Louisiana.

Geological distribution: Pleistocene.

Habitat: Found in rivers, ponds and lakes, in soft mud, either on the surface or buried to a considerable depth.

Remarks: This is a distinct little shell, and can be confounded with no other. It is a common and abundant species, and may be seen on any pleasant day jerking its way over the muddy bottom of our rivers. Its transverse outline differs from that of any other species found in this area, and will at once distinguish it. The species is found in the northern and western regions.

44. **Calyculina truncata** Linsley, pl. xxvii., fig. 8.

Cyclas calyculata DRAPARNAUD, C. B. ADAMS, Amer. Jour. Sci. and Arts, 2d series, Vol. XL., p. 277, 1841.

Cyclas truncata LINSLEY, Amer. Jour. Sci. and Arts., 3d series, Vol. VI., p. 234, fig. 3, 1848.

Cyclas lenticula GOULD, Proc. Bost. Soc. N. H., Vol. III., p. 256, 1850.

Cyclas pellucida PRIME, STIMPSON, Shells of New England, p. 16, 1851.

Shell: Very fragile, small, inflated, almost equilateral, rhombic-ovate, translucent; umbones prominent, elevated, full, calyculate, approximating, placed centrally, smooth and shining; dorsal margin straight; ventral margin broadly rounded; anterior margin rounded; posterior margin sharply truncated, rounded on the ventral part; umbonal slopes rounded; surface smooth and shining, lines of growth very fine; color light yellowish green or greenish horn with a zone of yellow bordering the ventral margin of the valve; ligament weak, light horn color; cardinal teeth small, a single, elevated, lamellar, arched tooth in the right valve, and two teeth in the left valve, the ventral tooth pyramidal, elevated, the dorsal tooth long, lamellar, curved, and elevated; lateral teeth long, lamellar, elevated, straight, one in the left valve and two in the right valve; muscle scars scarcely visible; cavity of the beaks shallow; nacre light bluish with a yellow zone on the ventral border.

Length, 9 25; height, 7.50; breadth, 5.00 mill. (12464).
" 7.50; " 6.50; " 3.50 " (12464).

Animal: Not observed.

Distribution: New England west to Illinois and Wisconsin, Canada south to Kentucky.

Geological distribution: Pleistocene.

Habitat: In small ponds and sheltered parts of rivers, in soft, sticky mud.

Remarks: This species is very like *S. transversa*, but is shorter in comparison with its height, is rhombic in form and the beaks are placed centrally. The two species belong to a natural group of which *transversa* is the leading form. It is not as common as *transversa* and is confined to the lower part of the western region.

45. **Calyculina securis** Prime, pl. xxvii., fig. 9.

Cyclas securis Prime, Proc. Bost. Soc. Nat. His., Vol. IV., p. 160, 1851; Ann. N. Y. Lyceum, Vol. V., p. 218, pl. vi., 1851.
Cyclas cardissa Prime, Proc. Bost. Soc. N. H., Vol. IV., p. 160, 1851.
Cyclas crocea Lewis, l. c., Vol. V., p. 25, 1854.

Shell: Small, fragile, but stouter than the two previous species, inflated, inequilateral, rhombic-orbicular; umbones elevated, full, much inflated, calyculate, approximate, placed a trifle anteriorly; marked by very fine lines of growth; dorsal margin arched; ventral margin rounded; anterior margin rounded, posterior truncated; umbonal slopes rounded, subangulate posteriorly; surface shining, lines of growth very faint; color varying from bright yellow to greenish horn, sometimes very dark horn; ligament as usual; cardinal teeth very small, a single, long, elevated, lamellar, arched tooth in the right valve, which has a large pyramidal projection near the anterior end giving the hinge the appearance of a double tooth, and two teeth in the left valve, one near the ventral margin of the hinge plate, elevated, pyramidal, and one near the dorsal border, lamellar, depressed, curved, extending diagonally toward the ventral border; lateral teeth long, lamellar, elevated, slightly curved, one in the left valve and two in the right; muscle scars faint; cavity of the beaks deep; nacre bluish white, darker near the postero-ventral portion, lighter in yellowish specimens

Length, 6.00; height, 5.00; breadth, 3.00 mill. (12465).
" 5.50; " 4.50; " 2.50 " (12465).

Animal: Not observed.

Distribution: New England west to Michigan, Canada south to Kentucky.

Geological distribution: Pleistocene.

Habitat: Same as *S. truncata.*

Remarks: A species at once distinguished by its rhombic-orbicular outline and inflated beaks and shell. It is the smallest *Sphærium* found in this area, and is wider in proportion to its length than any other species. It does not seem to be very common, and, like the last species, is confined to the south-western part of the western region.

46. **Calyculina partumeia** Say, pl. xxvii., fig. 6.

Cyclas partumeia SAY, Journ. Phil. Acad., Vol. II., p. 380, 1822.
Cyclas cornea, var. 2, LAM., An. sans Vert., Vol. V., p. 558, 1818.
Cyclas orbicularia BARRATT, Amer. Journ. Sci. and Arts, Vol. XLVIII., p. 276, 1845.
Cyclas mirabilis PRIME, Proc. Bost. Soc. N. H., Vol. IV., p. 157, 1851.
Cyclas cærulea PRIME, l. c., p. 161, 1851.
Cyclas eburnea ANTHONY, l. c., p. 279, 1852.

Shell: Of good size, inflated, fragile, very nearly equilateral, pellucid; umbones elevated, inflated, of good size, placed near the center of the shell, calyculate, very finely marked by growth lines; dorsal margin slightly arched, ventral rounded; anterior margin broadly rounded, posterior roundly truncated; umbonal slopes rounded; surface shining, polished, marked by very fine growth lines; color greenish horn or yellowish, with frequently a broad zone of dark purple on the ventral border;

ligaments slight; cardinal teeth small, a single, long, elevated, curved tooth placed near the dorsal border of the hinge plate in the right valve, and two teeth in the left valve, the dorsal tooth being long, elevated, lamellar and curved, and the ventral tooth elevated, pyramidal and stout; lateral teeth long and straight, elevated, lamellar, double in the right and single in the left valve; the anterior part of the valve is rounded, but the posterior forms a decided angle with the hinge line; muscle scars barely visible; cavity of the beaks deep; nacre horn color, with a blue zone on the ventral margin.

Length, 6.00; height, 5.50; breadth, 3.00 mill. (8458).
'' 5.50; '' 5.00; '' 3.00 '' (10093).
'' 8.50; '' 7.75; '' 4.50 '' (12466).

Animal: Similar to that of *S. occidentale.*

Distribution: New England west to Iowa, Wisconsin south to Alabama, Louisiana and Florida.

Geological distribution: Pleistocene.

Habitat: Found in ponds and rivers, buried in black mud.

Remarks: This species is closely allied to *S. occidentale* Prime, but may be distinguished by its larger size, truncated posterior border and general rounded oval outline. It is one of our commonest species, and also one of the most beautiful of the genus. *Partumeia* is found in almost every part of the area, and is the most widely distributed of any species in the genus. It is a very handsome species when at its best, the shell being so thin that the animal may easily be seen through it.

GENUS **PISIDIUM** Pfeiffer.

"*Shell:* Small, rounded-oval, inequilateral, anterior side longer; beaks terminal; cardinal teeth double, at times united, situated immediately under the beaks; lateral teeth elongated, lamelliform, double in the right valve, single in the left valve; ligament always on the shorter side.

"*Animal:* Elongate-oval, compressed laterally; lobes of the mantle without tentacles, united posteriorly into a single, short siphonal tube; oral aperture small, tentacles of the mouth triangular, elongated; gills of medium size; foot small, tongue shaped, capable of great extension." (Prime.*)

"Posterior part of shell shorter than anterior; siphons quite short." (Sterki, in lit.)

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*Monograph of American Corbiculadæ, p. 59.

Pisidium differs from *Sphærium* principally in its siphonal tubes, which are united in the former for their whole distance, and in the latter are united only at the base. The foot also differs, being similar in some respects to *Cardium*. (Prime.) The beaks in *Pisidium* are placed near the *posterior* end, while in *Sphærium* they are placed centrally or near the *anterior* end.

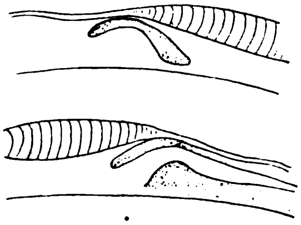

Fig. 11.

Cardinal teeth of PISIDIUM COMPRESSUM Prime (x 50, original). Upper figure, right valve; lower figure, left valve.

The mode of reproduction is the same in both genera. Pisidia may be more profitably collected during the spring and summer, "from the middle of April to the early part of July,"* this being the breeding season.

The cardinal teeth are sometimes quite similar to (Fig. 11) and again quite different (Fig. 12) from those of *Sphærium*. The teeth in *Pisidium* are generally more elongated than those of *Sphærium*. In one type (Fig. 11) the single cardinal in the right valve is long, narrow and curved, the lower part of the curve being thicker than the upper part, and placed near the ventral border of the hinge plate. The upper tooth in the left valve is

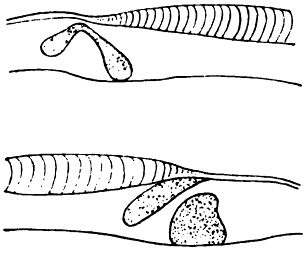

Fig. 12.

Cardinal teeth of PISIDIUM VIRGINICUM Bourg. (x 50, original). Upper figure, right valve; lower figure, left valve.

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*Prime, Monograph, p. 61.

long, very narrow and curved, and extends to a point about the center of the hinge plate; the lower tooth is more or less pyramidal, elevated and somewhat lamellar. In the second type (Fig. 12) the single right cardinal is very much arched, swollen at both ends of the arch, the right arm being the longer. The upper left cardinal is long and thick, elevated, lamelliform, and extends nearly to the ventral border of the hinge plate; the second left tooth is more or less rounded, pyramidal, elevated, and extends well toward the dorsal margin of the hinge plate.

Distribution: North and South America, Europe, New Zealand, India, Iceland, Greenland.

KEY TO SPECIES OF PISIDIUM.

a. Umbones placed very near the center of the shell, which is elongated oval in form.................... ....*abditum*
  1. Differs from "a" in being smaller, shorter and higher, the beaks less full, and the sculpture finer and more polished........................*politum*

b. Umbones placed near the posterior end of the shell.
  1. Shell very oblique, posterior end short, rounded, anterior end long, obtusely triangular, larger than (2)..................................*virginicum*
  2. Shell trigonal and triangular, more compressed than (1), posterior end short and rounded, anterior end much produced, beaks somewhat elevated and compressed...................*compressum*

47. **Pisidium Abditum** Haldeman, pl. xxviii., fig. 1.

Pisidium abditum Haldeman, Proc. Phil. Acad., p. 58, 1841.
Cyclas major C. B. Adams, Proc. Bost. Soc. N. H., p. 48, 1841.
Pisidium tenellum Gould, Agassiz, Lake Superior, p. 235, 1848.
Pisidium minus Stimpson, Shells of New England, p. 16, 1851.
Pisidium obscurum Prime, Proc. Bost. Soc. N. H., Vol. IV., p. 161, 1851.
Pisidium kurtzi Prime, l. c , p. 162, 1851.
Pisidium zonatum Prime, l. c., p. 162, 1851.
Pisidium rubellum Prime, l. c., p. 163, 1851.
Pisidium regulare Prime, Bost. Journ. Nat. Hist., Vol. VI., p. 363, pl. xii., fig. 11, 12, 1852.
Pisidium notatum Prime, l. c., p. 365, pl. xii., fig. 20-22, 1852.
Pisidium arcuatum Prime, l. c., p. 364, pl. xii., fig. 14-16, 1852.
Pisidium resartum Ingalls, in litt., 1855.
Pisidium rubrum Lewis, in litt., 1855.
Pisidium plenum Lewis, in litt., 1855.

Shell: Large (for the genus), inflated, rather solid, somewhat inequilateral, elongate-oval; umbones slightly raised, full, placed a little posterior of the center, very rough, sometimes showing growth lines plainly, but generally covered with little prominences; dorsal and ventral margins rounded; anterior margin long, broadly rounded; posterior margin short, rounded; umbonal slopes rounded; surface shining, lines of growth faint; color very light horn or yellowish; ligament short, dark horn; cardinal teeth small, a single, lamellar, elevated, arched tooth in the right valve; the right arm of the arch is longer than the left and reaches nearly to the ventral border of the hinge plate; the left valve is armed with two cardinal teeth, the dorsal tooth being very long, lamellar, elevated and peculiarly bent at the distal end; the ventral tooth is large, elevated and more or less pyramidal; lateral teeth strong, curved, elevated, but projecting much above the edge of the valve, double in the right and single in the left valve; cavity of the beaks shallow.

Length, 4.25; height, 3.00; breadth, 2.50 mill. (9883).

Animal: Not observed.

Distribution: New England west to California, Canada south to Louisiana, Florida and Honduras.

Geological distribution: Not known, probably Pleistocene.

Habitat: Found in the smaller lakes and streams, buried in soft, black mud, or on aquatic plants.

Remarks: This is a distinct and abundant species, distinguished by its elongated ovate outline. It is quite abundant and is universally distributed.

48. **Pisidium virginicum** Bourguignat, pl. xxviii., fig. 2.

Tellina virginica GMELIN, Syst. Nat., pp. 32, 36, pl. clix., fig. 15, 1788.
Tellina pusella (pars) DILLWYN, Cat., Vol. II., p. 106, 1817.
Cyclas dubia SAY, Nich. Encyc., 1st Am. Ed. II., p. 4, pl. i., fig. 10, 1817.
Physemoda aequalis RAFINESQUE, Ann. Gen. Sci. Phys. et Nat., Vol. V., p. 319, 1820.
Pisidium abruptum HALDEMAN, Proc. Phil. Acad., p. 53, 1841.
Pisidium virginicum BOURGUIGNAT, Rev. Mag. Zoöl., 1854.

Shell: Of good size, thick, not much inflated, inequilateral, very oblique; umbones not much elevated, prominent, full, placed near the posterior end of the shell, marked by growth lines; dorsal margin almost straight; ventral margin rounded; anterior margin broadly triangular, long; posterior margin short and rounded, sometimes appearing as if truncated; umbonal slopes rounded, sometimes inclining to angular anteriorly; surface shining, marked by heavy growth lines which are faint on the protoconch; color dark horn in old specimens, lighter in younger specimens, and zoned with light yellowish, especially near the ventral border; ligament as usual; cardinal teeth small, a single, elevated, arched tooth in the right valve, of which the right arm of the arch is the longest and reaches to the ventral border of the hinge plate; both arms are swollen at the ends and the arch forms as a whole, a letter V reversed; the left valve is armed with two teeth, the dorsal being thick, long, elevated and straight, and reaches nearly to the ventral edge of the hinge plate; the ventral tooth is large, rounded and pyramidal; lateral teeth strong, curved, elevated, smooth or only slightly striated, those of the left valve projecting strongly above the valve edge, those of the right valve not so much so, but projecting into the cavity of the shell; double in the right and single in the left valve; cavity of the beaks shallow; nacre glossy, inclining to purplish.

Length, 6.00; height, 5.00; breadth, 4.00 mill. (9879).

Animal: Not examined.

Distribution: New England west to Iowa, Canada south to Louisiana.

Geological distribution: Pleistocene.

Habitat: Same as *abditum*.

Remarks: A species easily recognized by its large size (it is the largest of the genus) and oblique form. It is one of the handsomest of the Pisidia. Thus far it has only been found in the southern region. Found fossil in sand banks east of Sheridan Drive and north of Graceland Avenue.

49. **Pisidium compressum** Prime, pl. xxviii., fig. 7.

Cyclas altilis Anthony, in litt., 1847.

Pisidium compressum Prime, Proc. Bost. Soc. N. H., Vol. IV., p. 164, 1851.

Pisidium cicer Prime, Ann. N. Y. Lyc., Vol. VI., p. 65, pl. i., fig. 1, 1853.

Shell: Small, solid, inflated, subequilateral, very oblique, trigonal; umbones elevated, drawn up and compressed, placed near the posterior end of the shell, marked by lines of growth; there is a wing shaped appendage on the summit of the beaks; dorsal margin very arcuate; ventral margin rounded; anterior margin long, narrow, produced; posterior margin short and rounded; umbonal slopes rounded; surface shining, marked by coarse growth lines; color yellowish, darker in old specimens; ligament as usual; cardinal teeth small, a single, long, curved tooth extending from near the ventral to the dorsal edge of the hinge plate, the right arm of the arch being long and swollen;

the left valve is armed with a dorsal long, narrow, lamellar, almost straight tooth, extending about half way to the ventral border of the hinge plate, and a large, rounded, pyramidal tooth placed near the ventral border; lateral teeth strong, elevated, curved, the right valve teeth strongly projecting above the valve edge, the left valve teeth not so much so; double in the right and single in the left valve; cavity of the beaks deep.

Length, 3 50; height, 3.00; breadth, 2.50 mill. (9880).
" 4.50; " 4.50; " 3.00 " (12468).

Animal: Not observed.

Distribution: New England west to California, Canada south to Arizona and New Mexico.

Geological distribution: Pleistocene.

Habitat: Similar to *abditum*.

Remarks: The winged beaks are a peculiarity of this species which will aid in its determination, although the appendages are not always present. Its trigonal form is different from any other species of the genus found in the region under discussion. It is found in both the western and southern regions.

50. **Pisidium politum** Sterki, unfigured
Pisidium politum STERKI, The Nautilus, Vol. IX., p. 75, 1895.

"Mussel of medium size, well inflated, rather high, beaks slightly posterior, rather high and prominent, not full but well rounded; scutum and scutellum slightly marked. Superior margin rather short, rather strongly curved; inferior well curved, more so in front than behind; posterior margin distinctly truncated, with a well marked angle where joining the superior, and a less marked, rounded angle where joining the inferior margin; anterior end forming a slight but distinct angle situated rather high up. Surface very finely, irregularly striated, polished; whitish or straw colored, often leaden grayish on the beaks, or even all over. Shell moderately thick; nacre whitish; muscular insertions not very distinct; hinge of essentially the same type as that in *Pis. abditum*.

"Length, 4.0; altitude, 3.4; diameter, 2.4 mill.; 4.7; 4.0; 2.9 mill. from another place.

"*Pis. politum* is rather variable in size, and more so in color as noted above, but so markedly constant in its several habitats that a number of different local forms, or varieties could be described. It has some resemblance with *Pis. abditum* Hald.

and *Pis. variabile* Pr.; from the former it is different by its being somewhat smaller, comparatively shorter and higher, the beaks being less full, the surface finer striated and more polished; from the latter it is distinguished by its smaller size, the beaks being less full, the antero-superior margin less straight, and the angle at the anterior end being situated higher up; the shell is thinner and the hinge less strong, the coloration different. With all these differences appearing only gradual, our *Pisidium* is a good species beyond a doubt and will always be recognized." (Sterki.)

Distribution: This species has been found thus far at the following localities: New Philadelphia, Ohio; Philadelphia, Pa.; Grand Rapids, Mich.; Clearwater River and Dallas Lake, Minn.; Joliet, Ill.

Habitat: Found in company with *Pis. abditum* and *compressum.**

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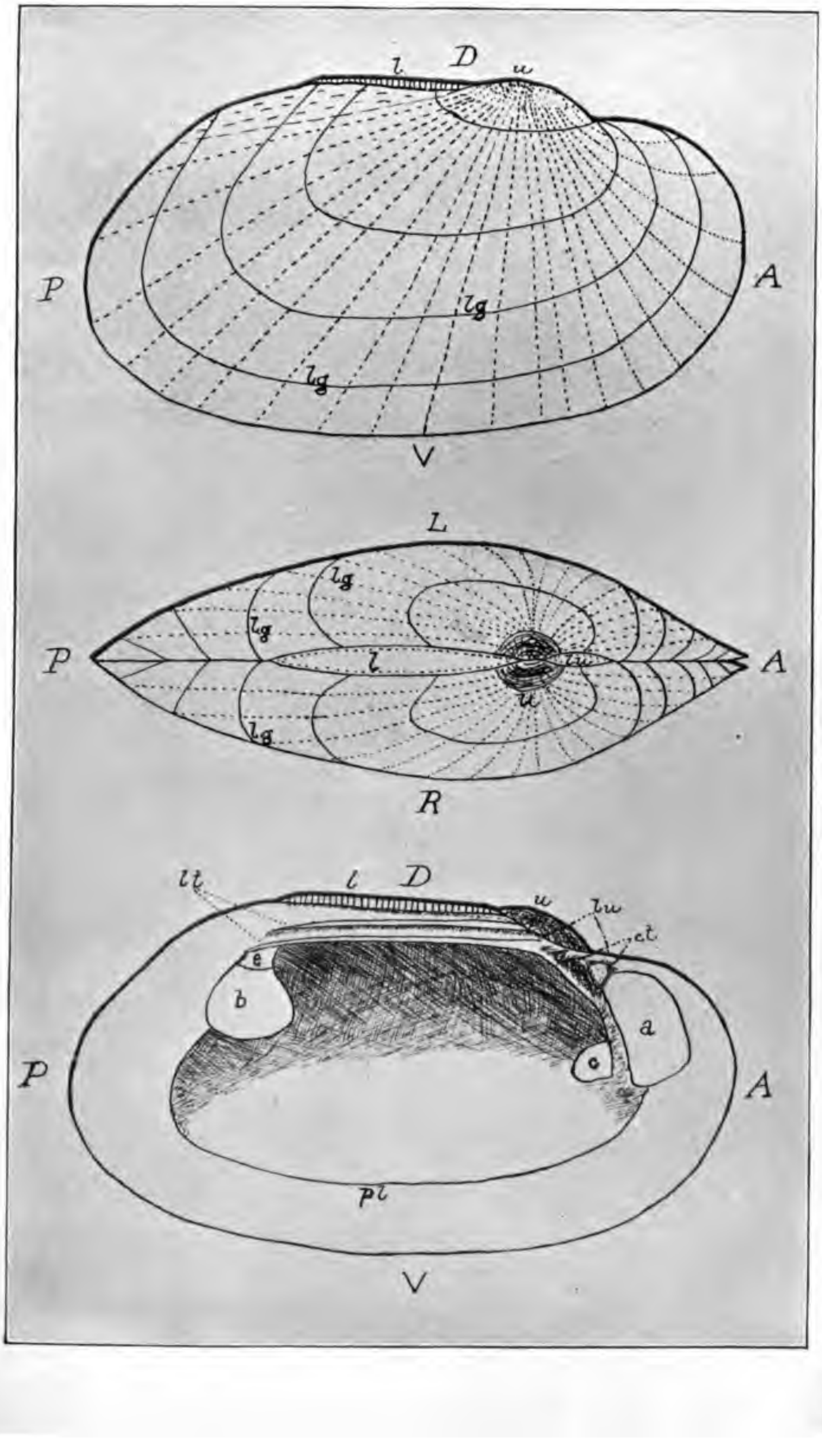
*Besides the foregoing there are a number of forms of *Sphæria* and *Pisidia* now in the hands of Dr. V. Sterki, which he has not fully investigated. When these are determined, no doubt many new forms will be added to our fauna.

EXPLANATION OF PLATE I.

UNIO LUTEOLUS Lamarck, showing different parts of shell. Upper figure, right valve, exterior; middle figure, both valves viewed from above; lower figure, left valve, interior. A, Anterior end. P, Posterior end. D, Dorsal margin. V, Ventral margin. R, Right valve. L, Left valve. a, Anterior adductor muscle-scar (or *cicatrix*). b, Posterior adductor muscle-scar. c, Anterior foot retractor muscle-scar. e, Posterior foot retractor muscle-scar. ct, Cardinal teeth. lt, Lateral teeth. l, Ligament. lg, Lines of growth. lu, Lunule. pl, Pallial line. u, Umbo.

PLATE I.



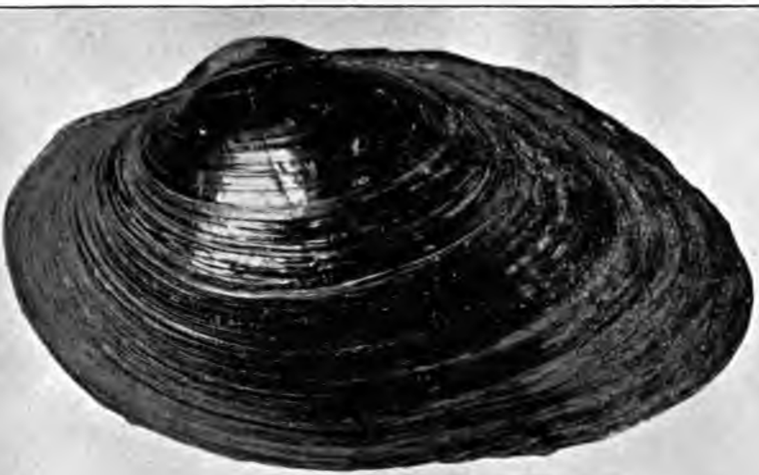
EXPLANATION OF PLATE II.

Figures 1, 2, 3. ANODONTA GRANDIS Say. ♂

Figures 4, 5. ANODONTA GRANDIS Say. Juvenile.

¾ natural diameter.

PLATE II.



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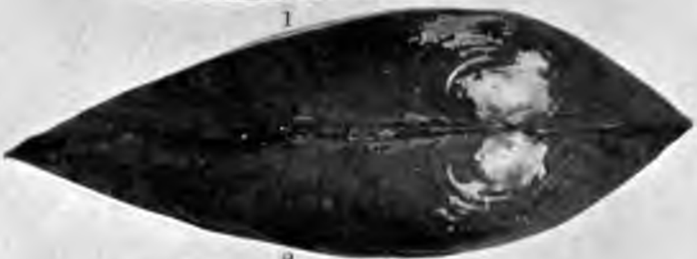

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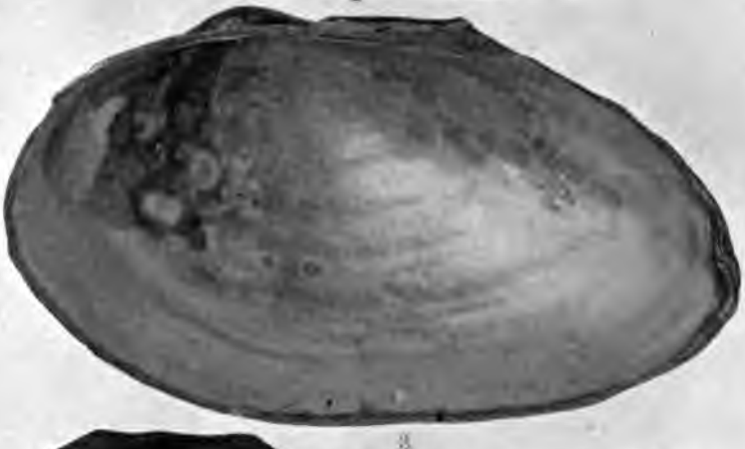

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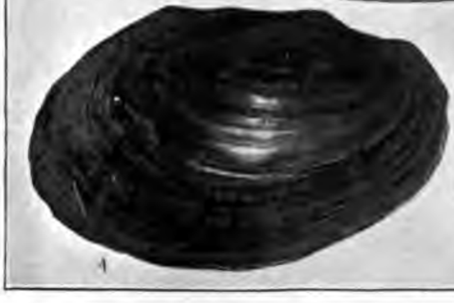

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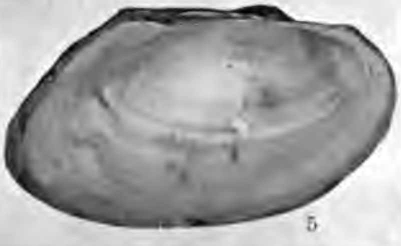

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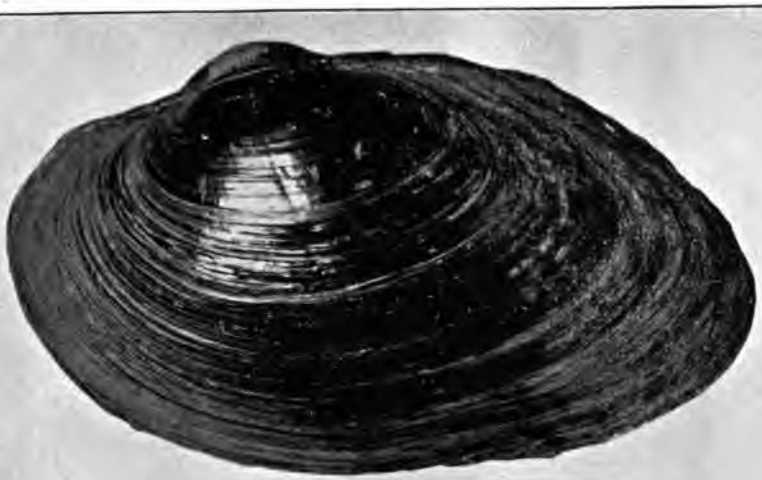
EXPLANATION OF PLATE II.

Figures 1, 2, 3. Anodonta grandis Say. ♂

Figures 4, 5. Anodonta grandis Say. Juvenile.

¾ natural diameter.

PLATE II.



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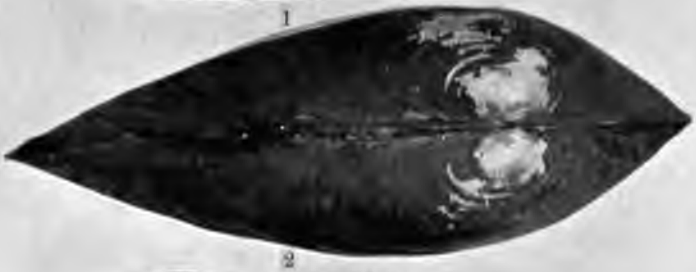

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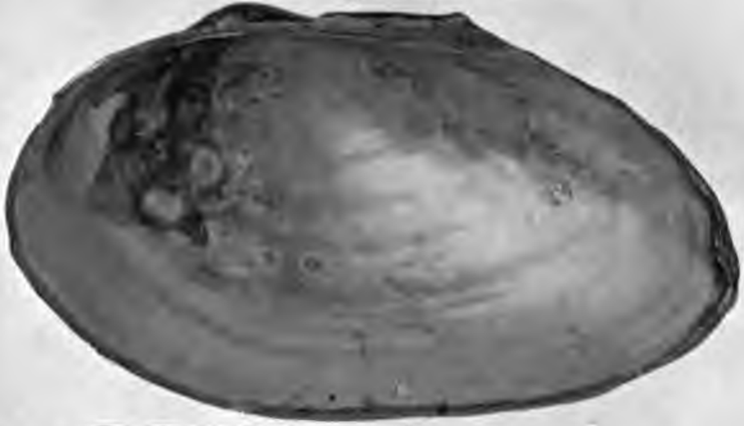

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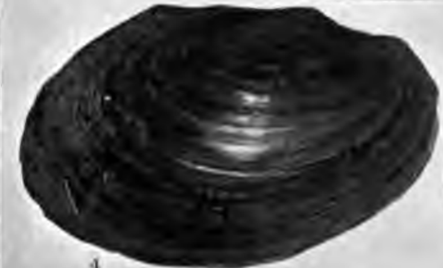

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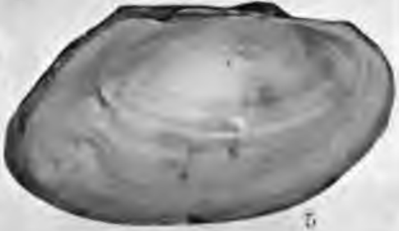

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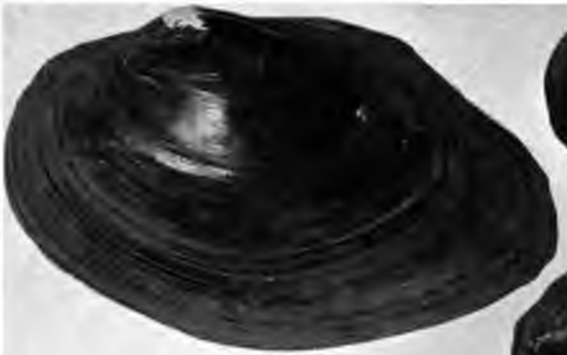
EXPLANATION OF PLATE III

Figure 1. Anodonta grandis Say. ♂
" 2. Anodonta footiana Lea. ♀
" 3. Anodonta footiana Lea. ♂
" 4. Anodonta footiana Lea. Juvenile.
" 5. Strophitus pavonius Lea.
" 6. Anodontoides ferussacianus Lea. Juvenile.

¾ natural diameter.

PLATE III.



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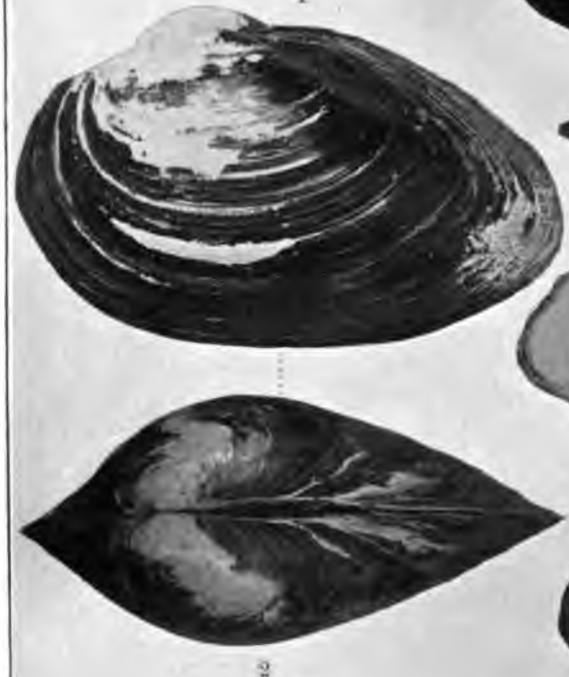

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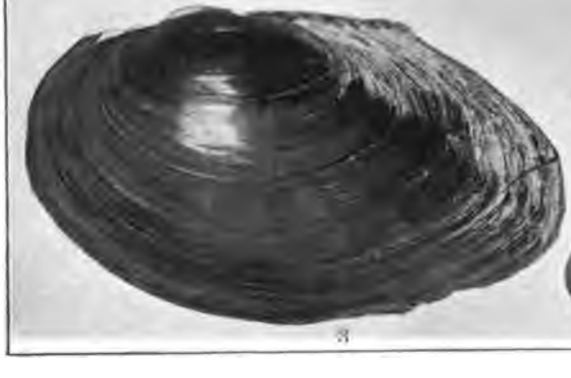

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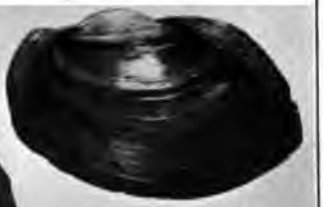

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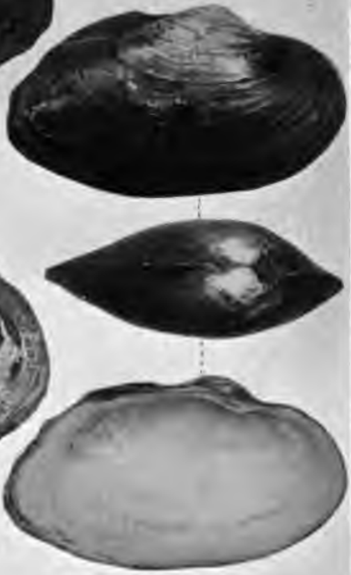

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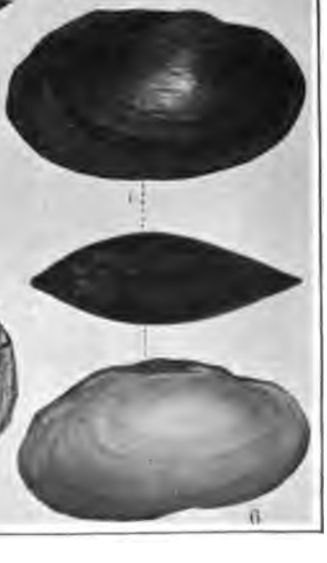

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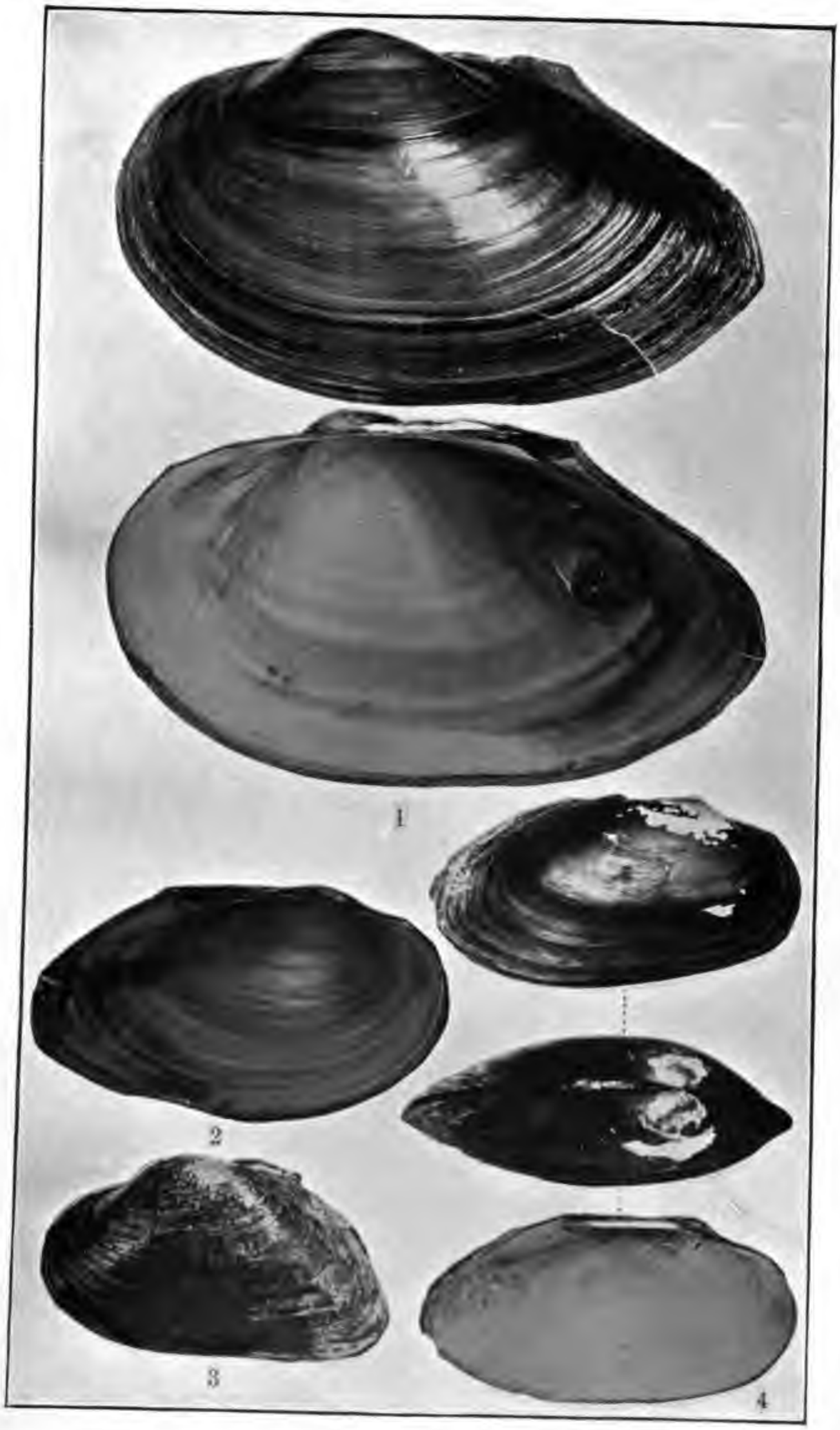
EXPLANATION OF PLATE IV.

Figure 1. Anodonta grandis Say. ♀
" 2. Anodonta footiana Lea. ♂
" 3. Alasmodonta marginata Say.
" 4. Anodontoides subcylindraceus Lea. ♀

¾ natural diameter.

PLATE IV.



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EXPLANATION OF PLATE V.

Figure 1. Anodonta imbecilis Say. The upper figure is a female, the others are males

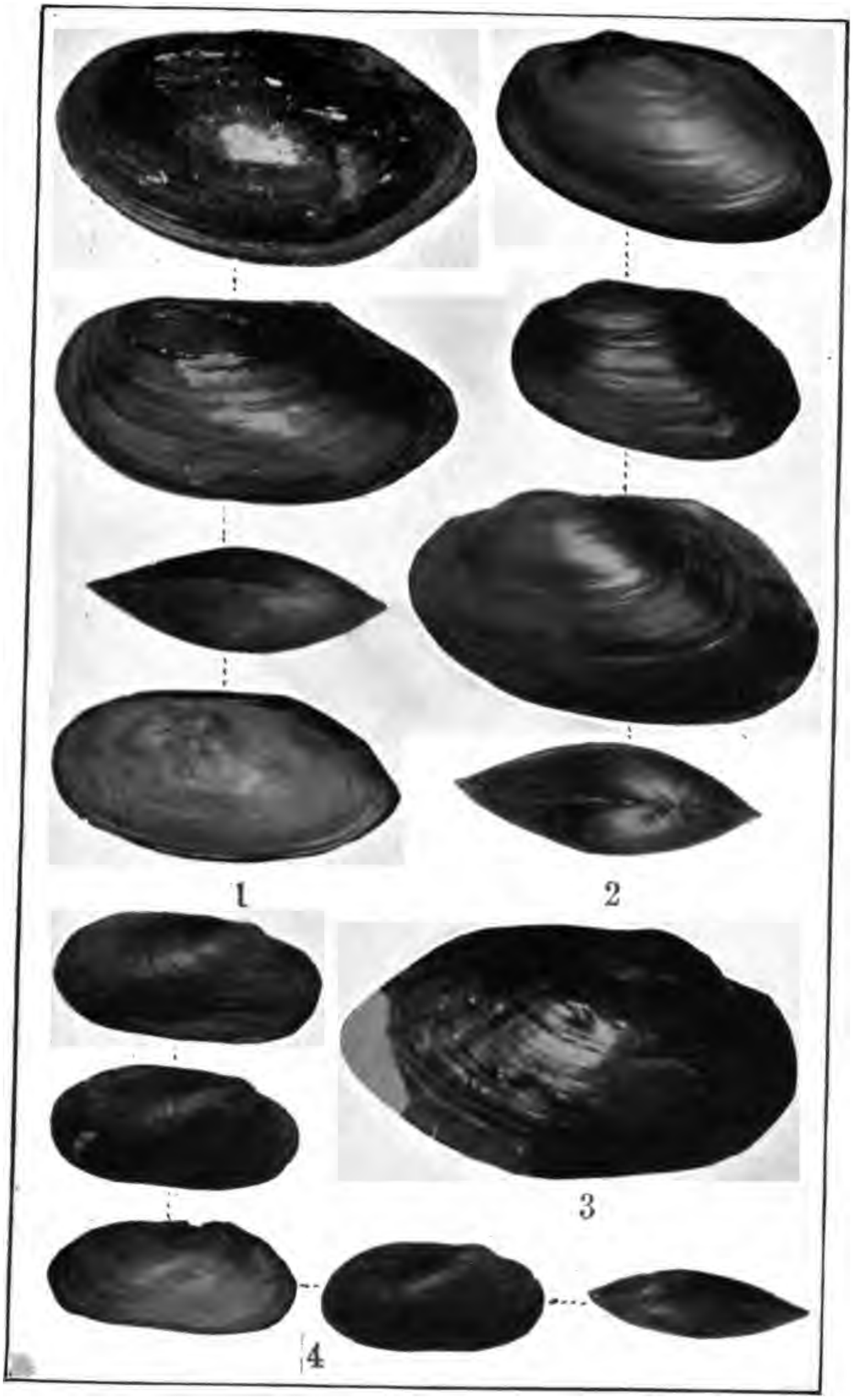
Figure 2. Anodontoides ferussacianus Lea.

" 3. Strophitus pavonius Lea.

" 4. Unio hildrethianus Lea.

$\frac{4}{5}$ natural diameter.

PLATE V.



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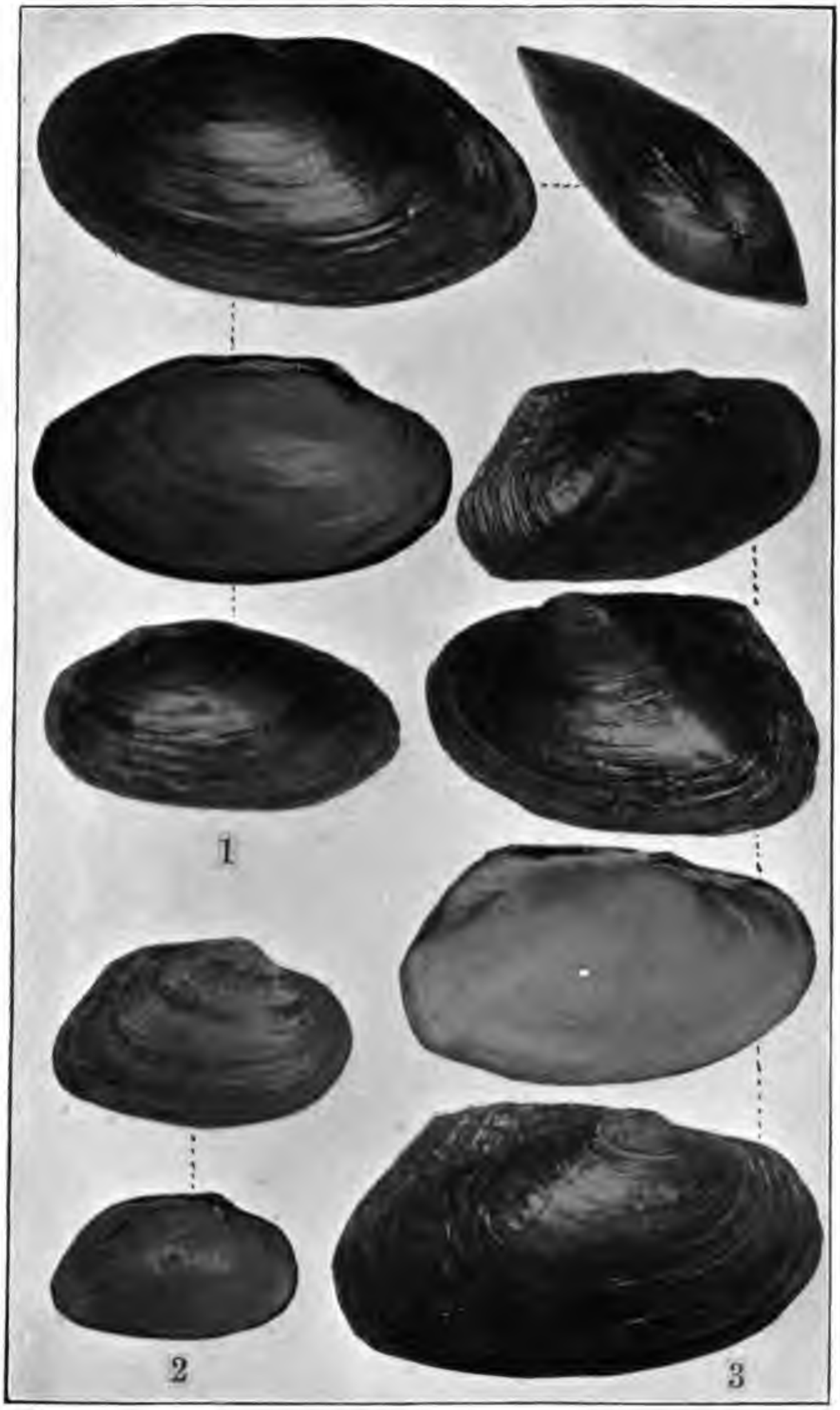
EXPLANATION OF PLATE VI.

Figure 1. ANODONTOIDES SUBCYLINDRACEUS Lea. ♂
" 2. ALASMODONTA CALCEOLA Lea (deltoideus Lea.)
" 3. ALASMODONTA PRESSA Lea.
⅘ natural diameter.

PLATE VI.



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EXPLANATION OF PLATE VII.

Figure 1. ALASMODONTA RUGOSA Barnes. ¾ natural diameter.

Figure 2. ALASMODONTA RUGOSA Barnes. Showing dark border on edge of interior. ¾ natural diameter.

Figure 3. ALASMODONTA EDENTULA Lea. Natural size.

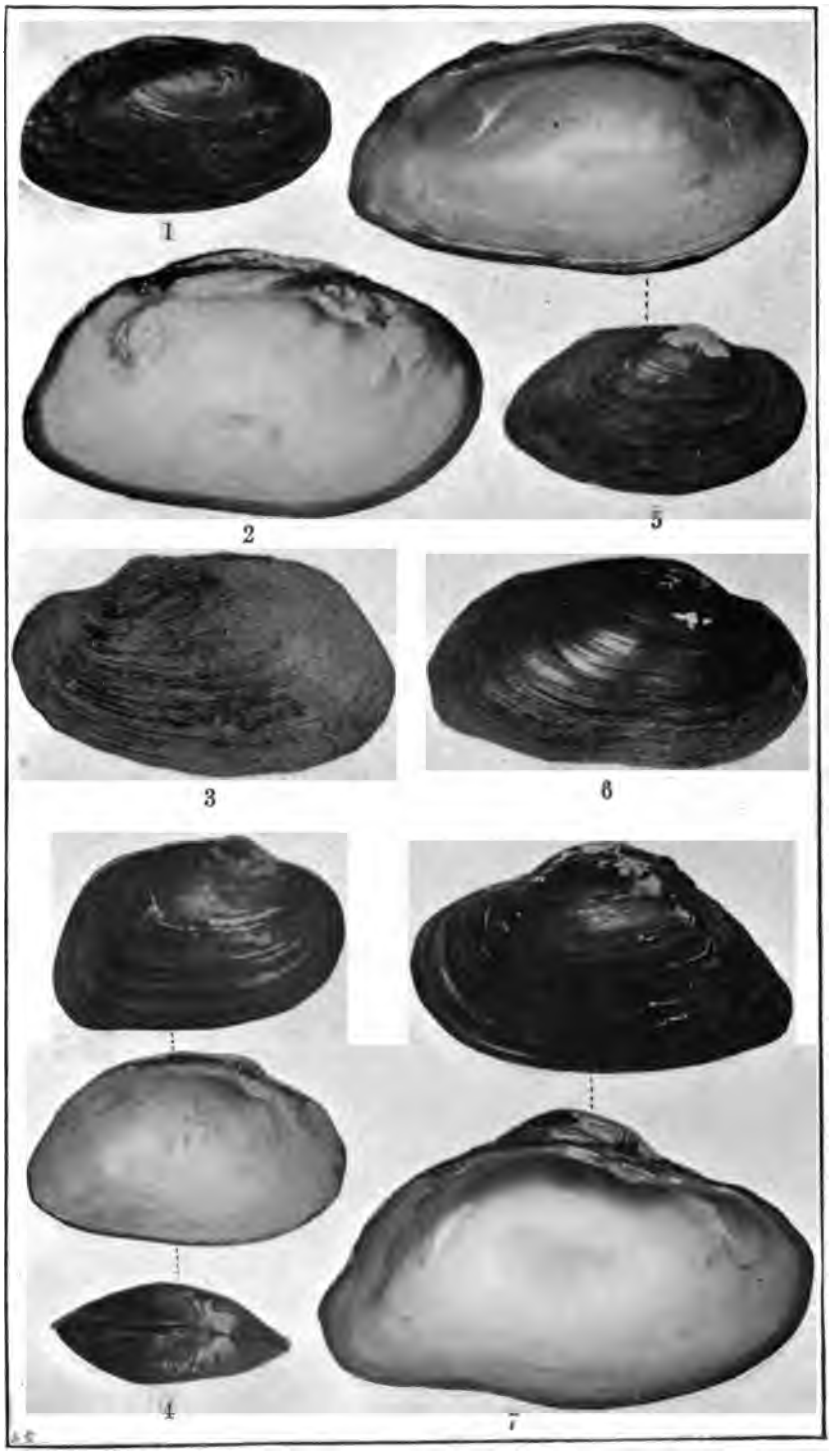
" 4. ALASMODONTA DELTOIDEA Lea. ⅘ natural diameter.

Figure 5. ALASMODONTA EDENTULA Lea. ♂ ¾ natural diameter.

Figure 6. ALASMODONTA EDENTULA Lea. ♀ ¾ natural diameter.

Figure 7. ALASMODONTA MARGINATA Say. ¾ natural diameter.

PLATE VII.



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EXPLANATION OF PLATE VIII.

Figure 1. ALASMODONTA COMPLANATA Barnes. ½ natural diameter.

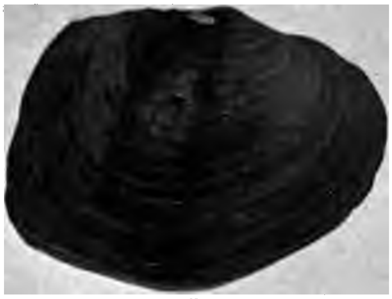
Figure 2. ALASMODONTA COMPLANATA Barnes. ♀ ½ natural diameter.

Figure 3. ALASMODONTA RUGOSA Barnes. ¾ natural diameter.

Figure 4. ALASMODONTA RUGOSA Barnes. ¾ natural diameter.

Figure 5. ANODONTA FOOTIANA Lea. ⅔ natural diameter.

PLATE VIII.



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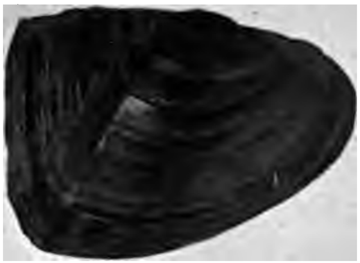

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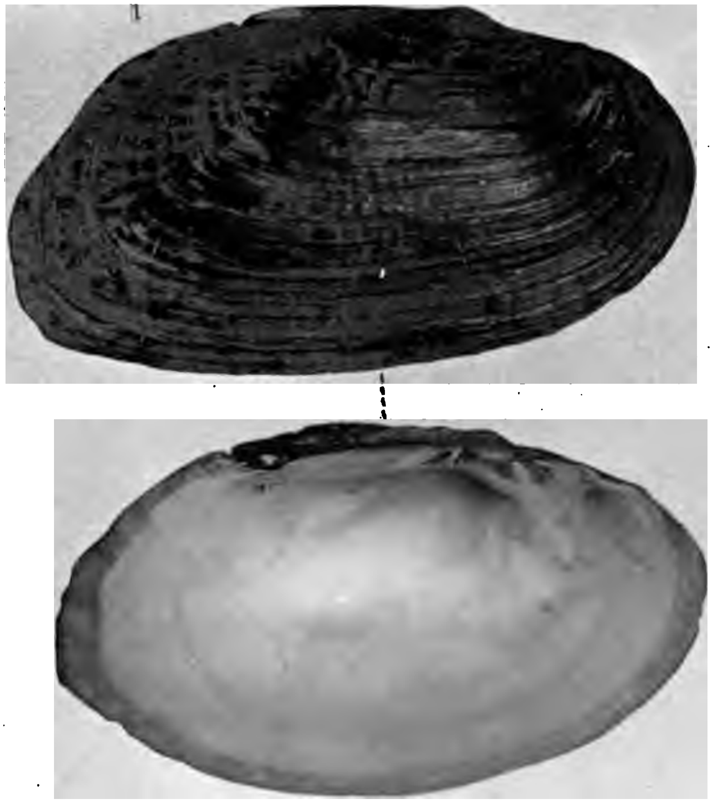

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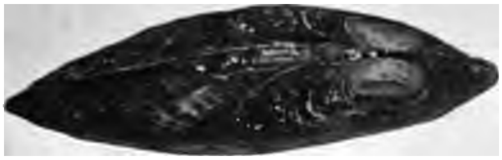

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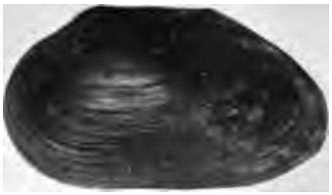

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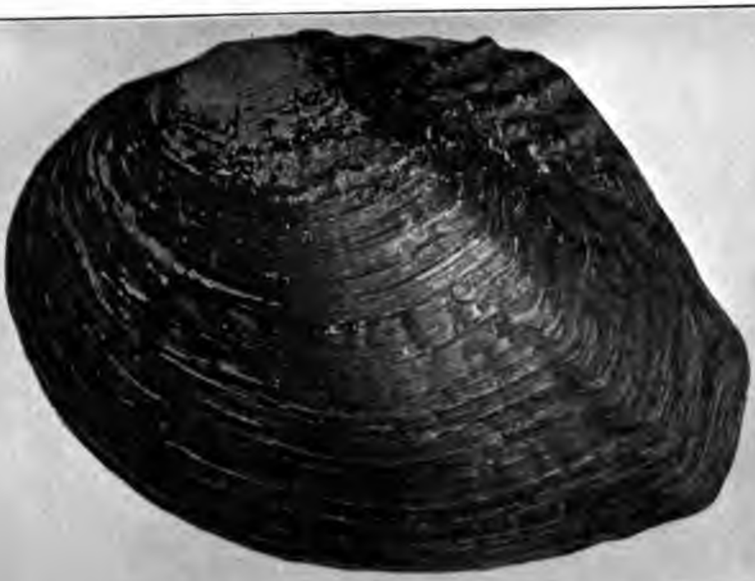
EXPLANATION OF PLATE IX.

ALASMODONTA COMPLANATA Barnes. 1, 2, 3, males. 4, Juvenile.

¾ natural diameter.

PLATE IX.



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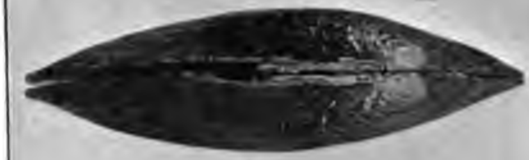

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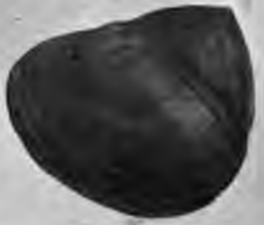

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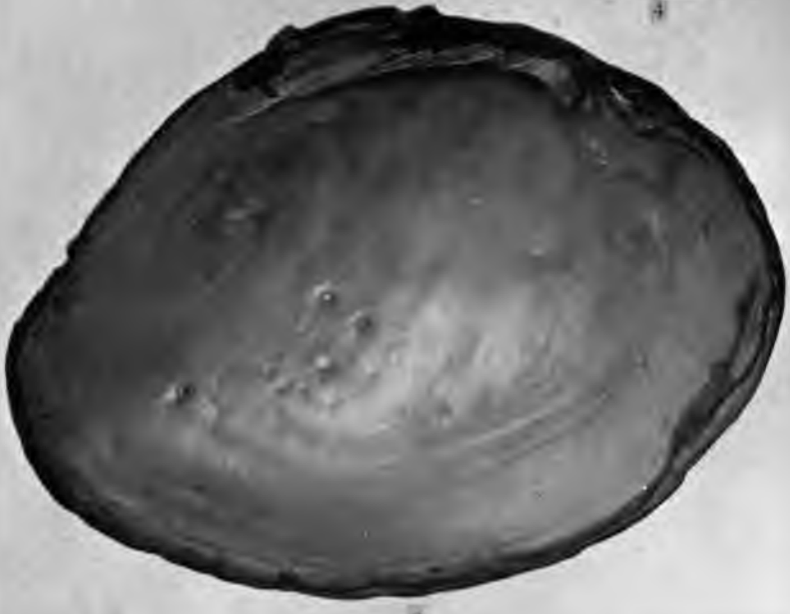

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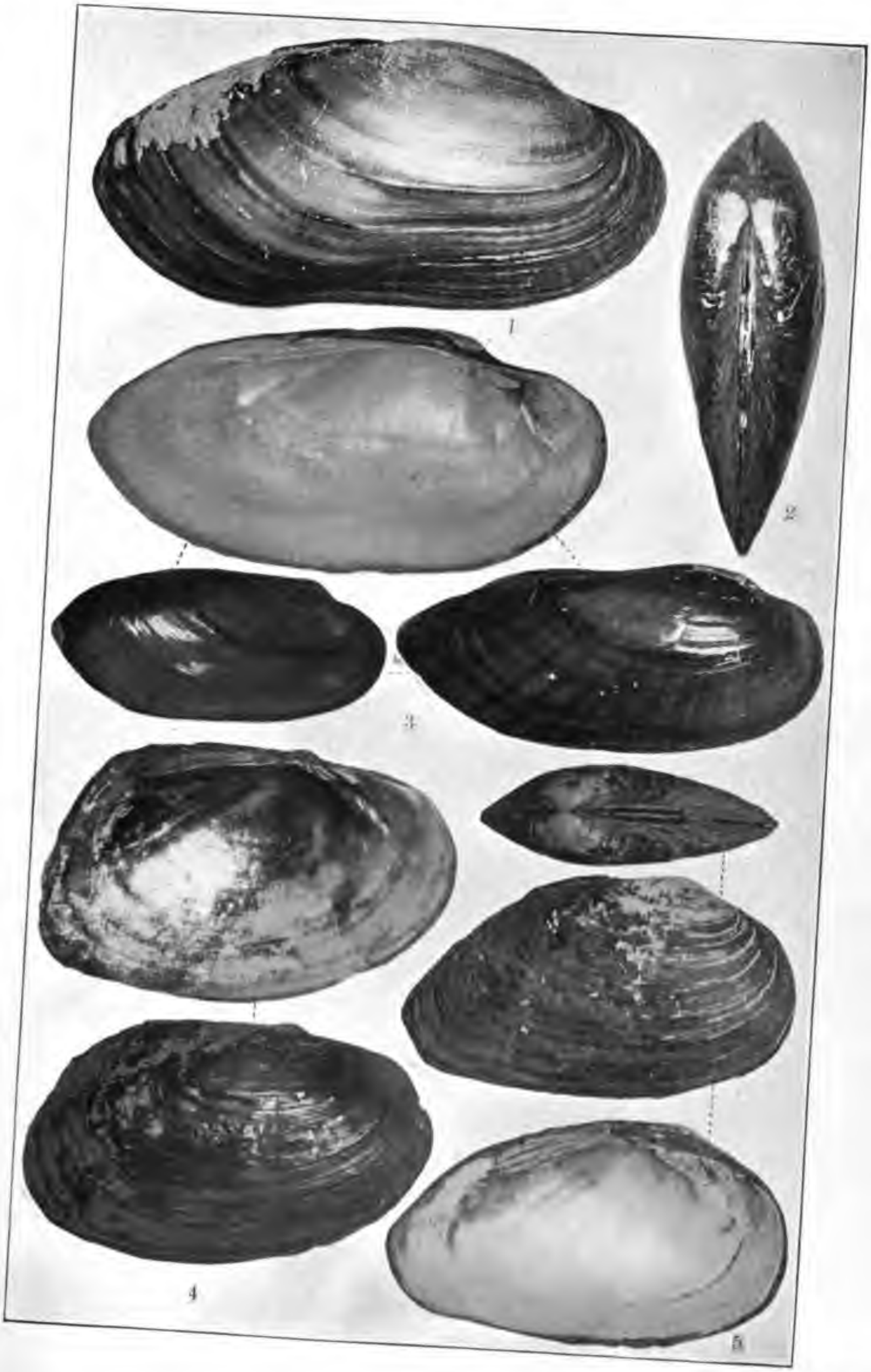
EXPLANATION OF PLATE X

Figure 1. Lampsilis anodontoides Lea. ♀
'' 2. Lampsilis anodontoides Lea. ♂
'' 3. Lampsilis anodontoides Lea. ♂
'' 4. Alasmodonta pressa Lea.
'' 5. Lampsilis spatulatus Lea.

¾ natural diameter.

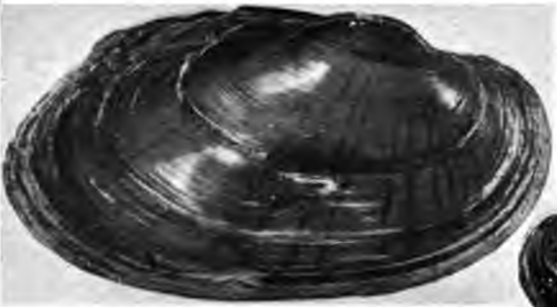
PLATE X.



EXPLANATION OF PLATE XI

Figures 1, 2, 3, 4, 5, 6. LAMPSILIS LUTEOLUS Lam. ♂
" 7, 8, 9, 10, 11. LAMPSILIS LUTEOLUS Lam. ♀
" 12, 13. LAMPSILIS LUTEOLUS Lam. Juvenile.
¾ natural diameter.

PLATE XI.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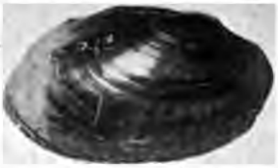
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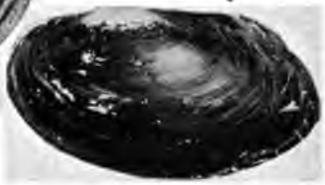
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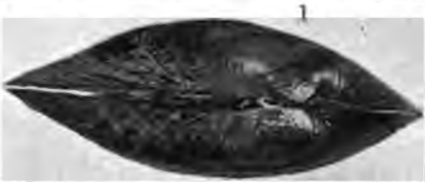
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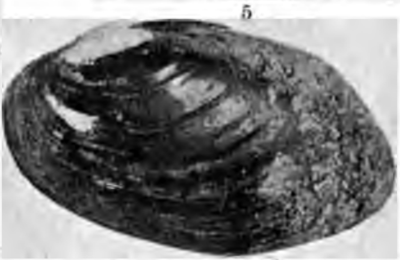
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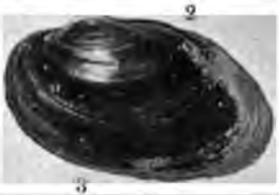
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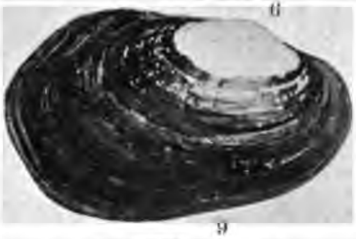
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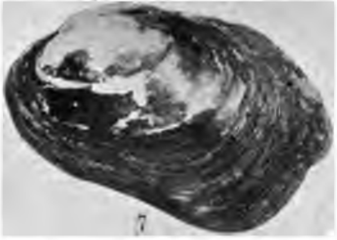
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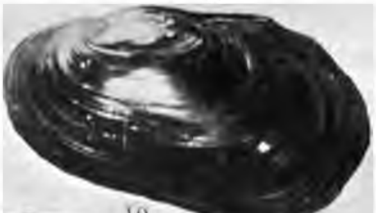
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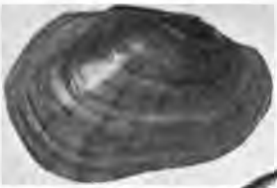
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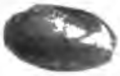
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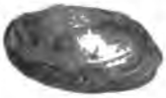
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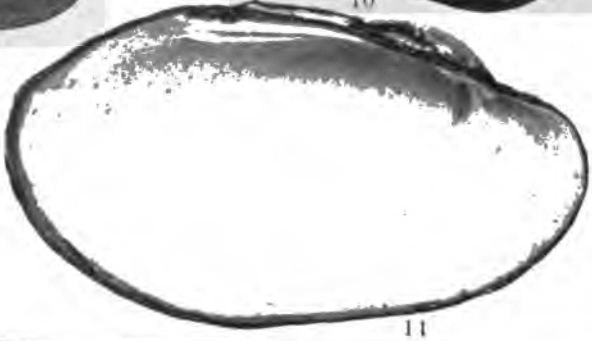
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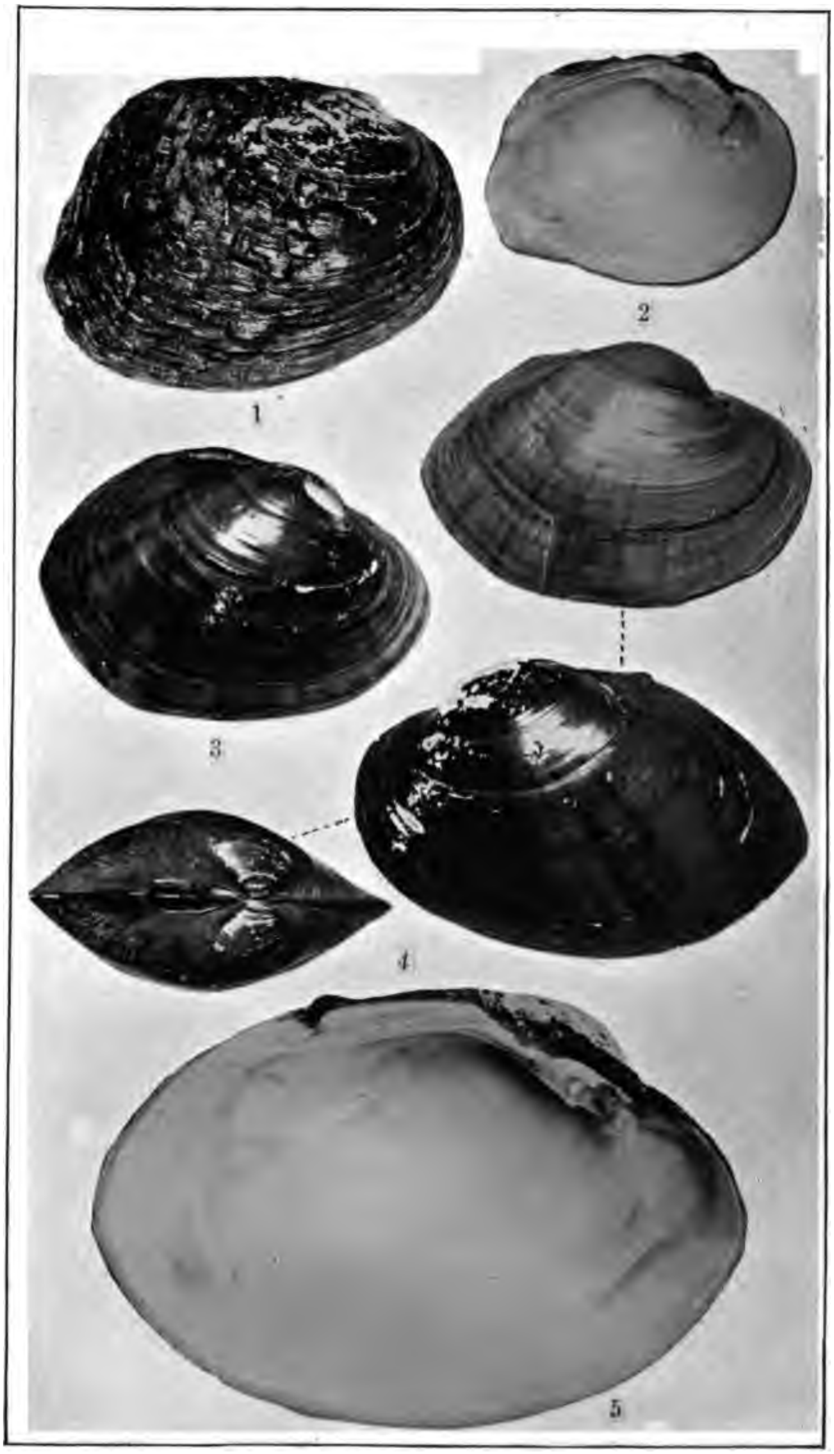
EXPLANATION OF PLATE XII.

Figure 1. QUADRULA UNDULATA Barnes. Undulations almost obsolete.

Figure 2. QUADRULA LACHRYMOSA Lea.
" 3. LAMPSILIS VENTRICOSUS Barnes. ♀
" 4. LAMPSILIS VENTRICOSUS Barnes. ♂
" 5. LAMPSILIS VENTRICOSUS Barnes. ♂

⅔ natural diameter.

PLATE XII.

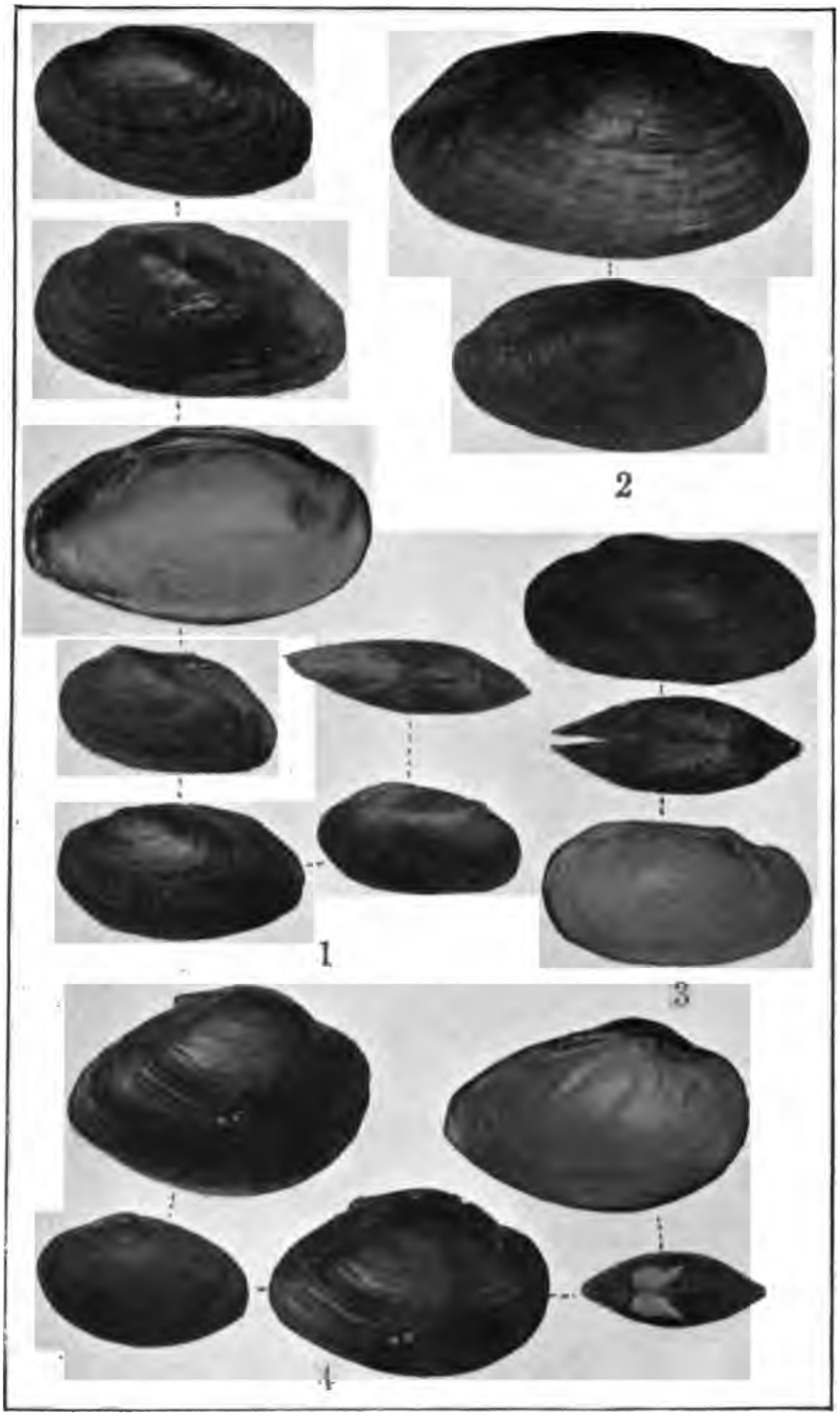


UNIV

EXPLANATION OF PLATE XIII.

Figure 1. LAMPSILIS IRIS Lea.
" 2. LAMPSILIS SPATULATUS Lea.
" 3. LAMPSILIS PARVUS Barnes.
" 4. PLAGIOLA DONACIFORMIS Lea.
¾ natural diameter.

PLATE XIII.

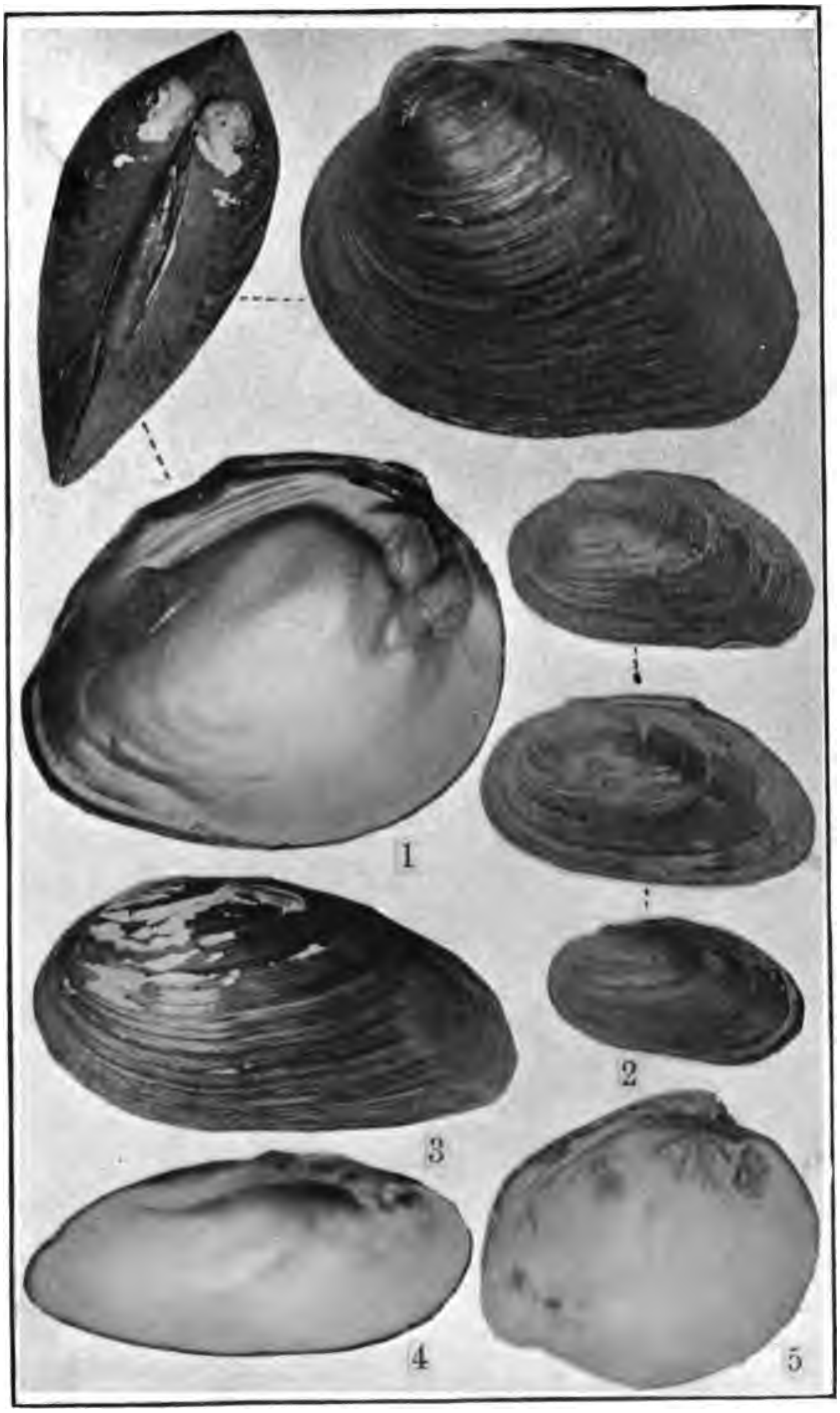


EXPLANATION OF PLATE XIV.

Figure 1. Quadrula coccinea Lea.
" 2. Lampsilis iris Lea.
" 3. Unio gibbosus Barnes. ♀
" 4. Unio gibbosus Barnes. ♂
" 5. Obliquaria reflexa Rafinesque.

¾ natural diameter.

PLATE XIV.

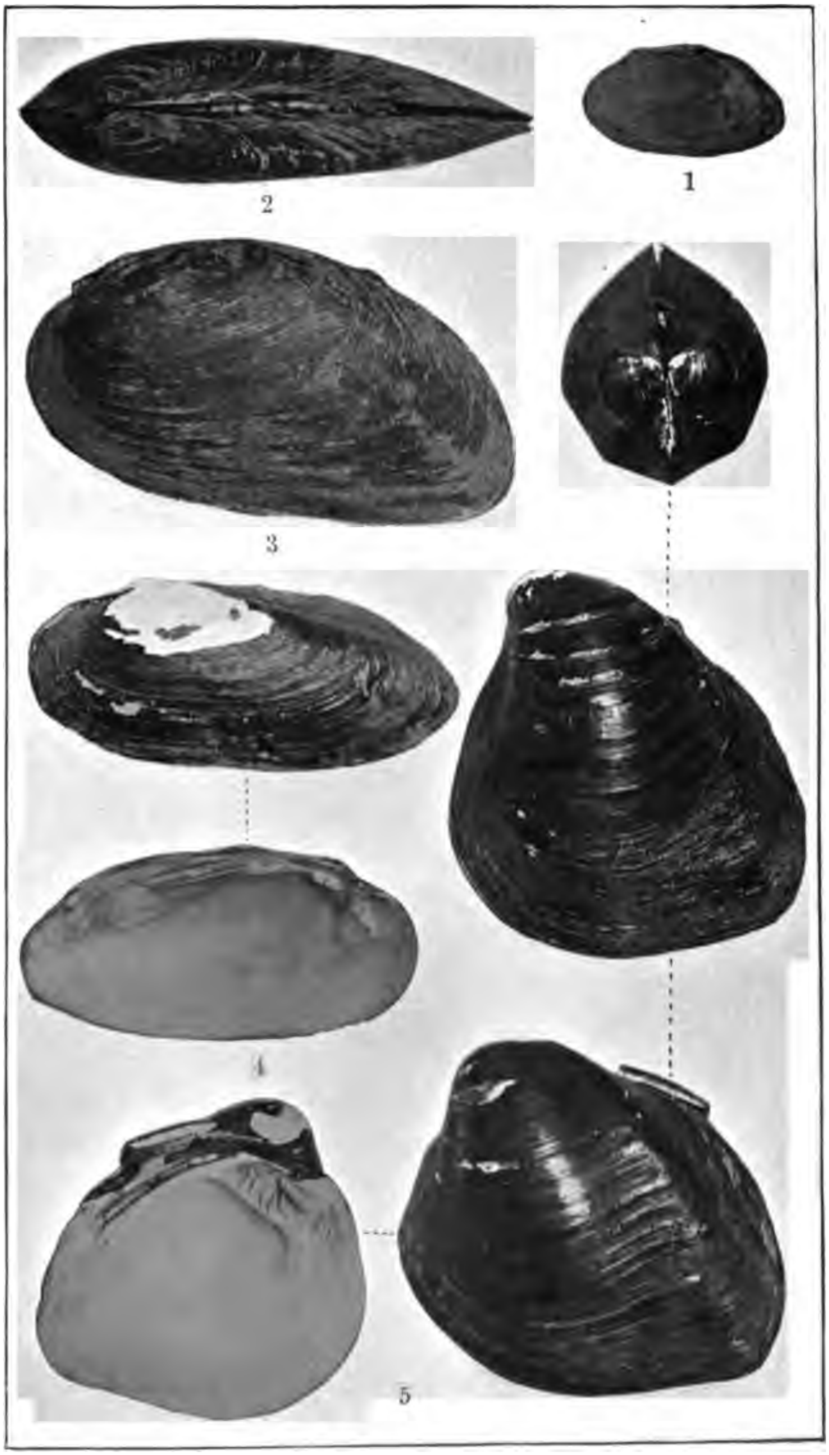


EXPLANATION OF PLATE XV.

Figure 1. Unio gibbosus Barnes. ♂ Juvenile.
" 2. Unio gibbosus Barnes. ♂
" 3. Unio gibbosus Barnes. ♀
" 4. Unio gibbosus Barnes. ♂
" 5. Quadrula trigona Lea.

¾ natural diameter.

PLATE XV.

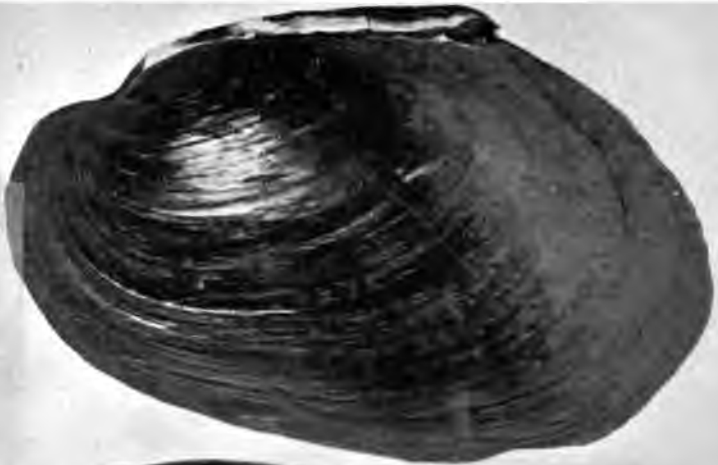


EXPLANATION OF PLATE XVI.

Figures 1, 2, 3, 4. LAMPSILIS LIGAMENTINUS Lam.

¾ natural diameter.

Plate XVI.



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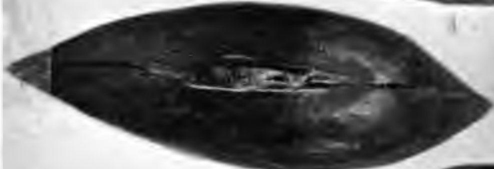

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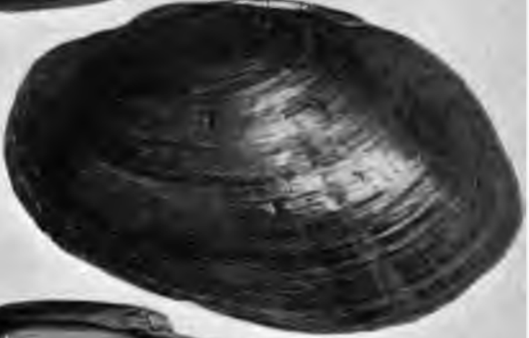

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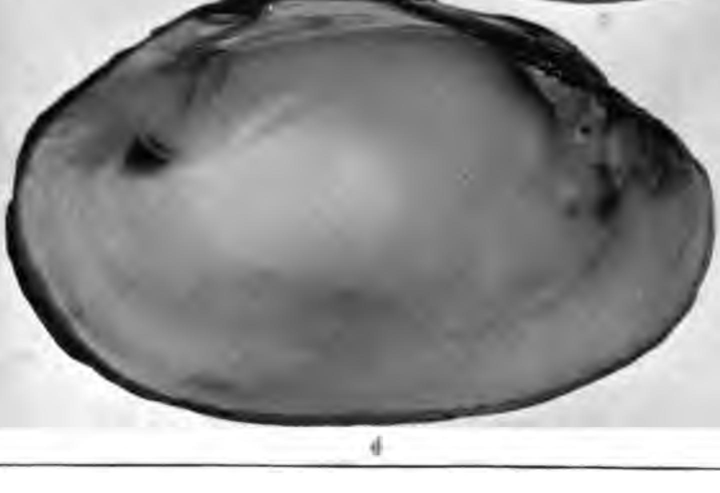
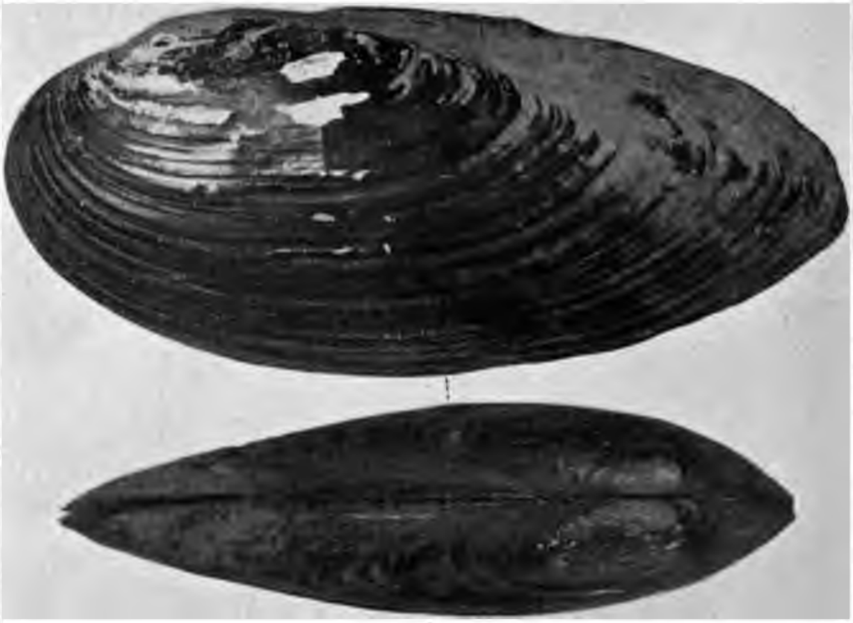


4

EXPLANATION OF PLATE XVII.

Figure 1. **Lampsilis rectus** Lamarck. ♂
" 2. **Lampsilis rectus** Lamarck. ♀
" 3. **Strophitus edentulus** Say.
¾ natural diameter.

PLATE XVII.



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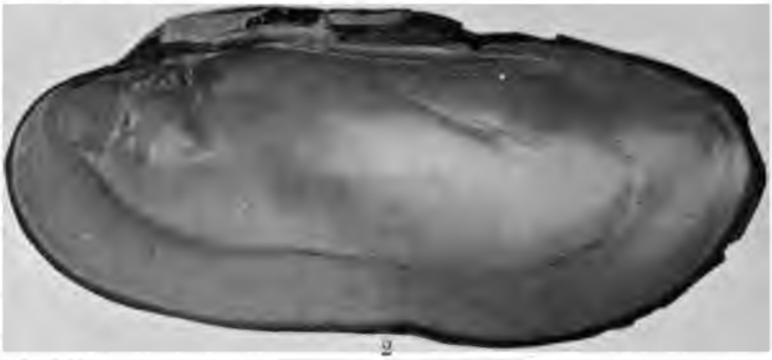

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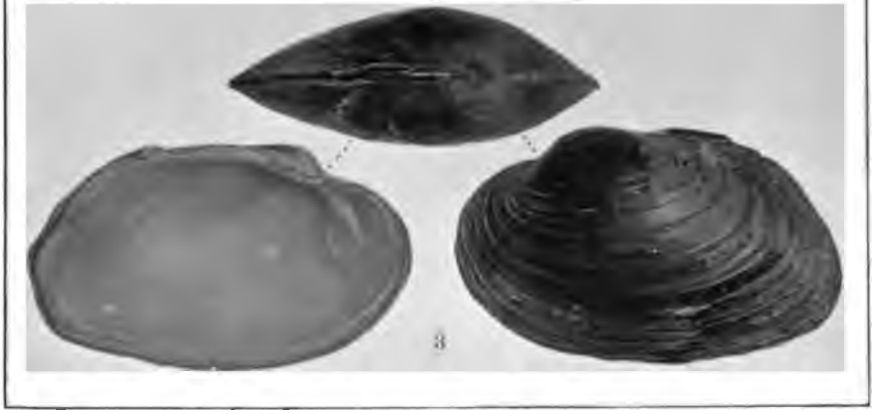

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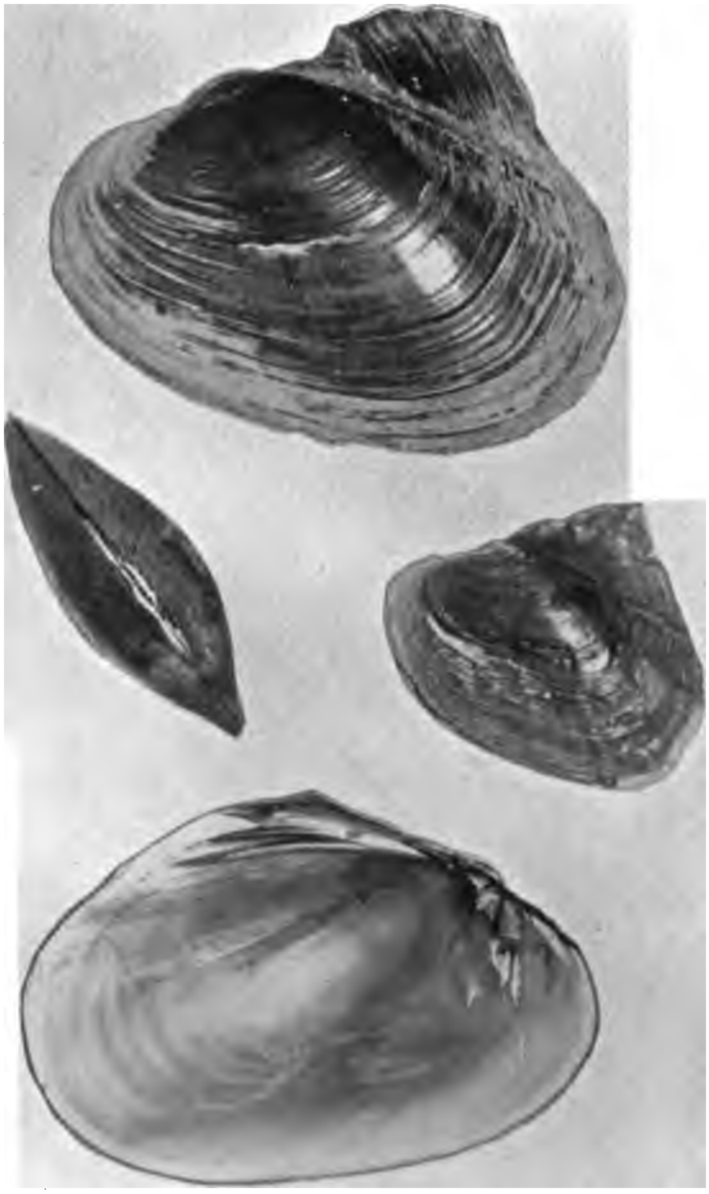
EXPLANATION OF PLATE XVIII.

LAMPSILIS ALATUS Say. ½ natural diameter.

PLATE XVIII.

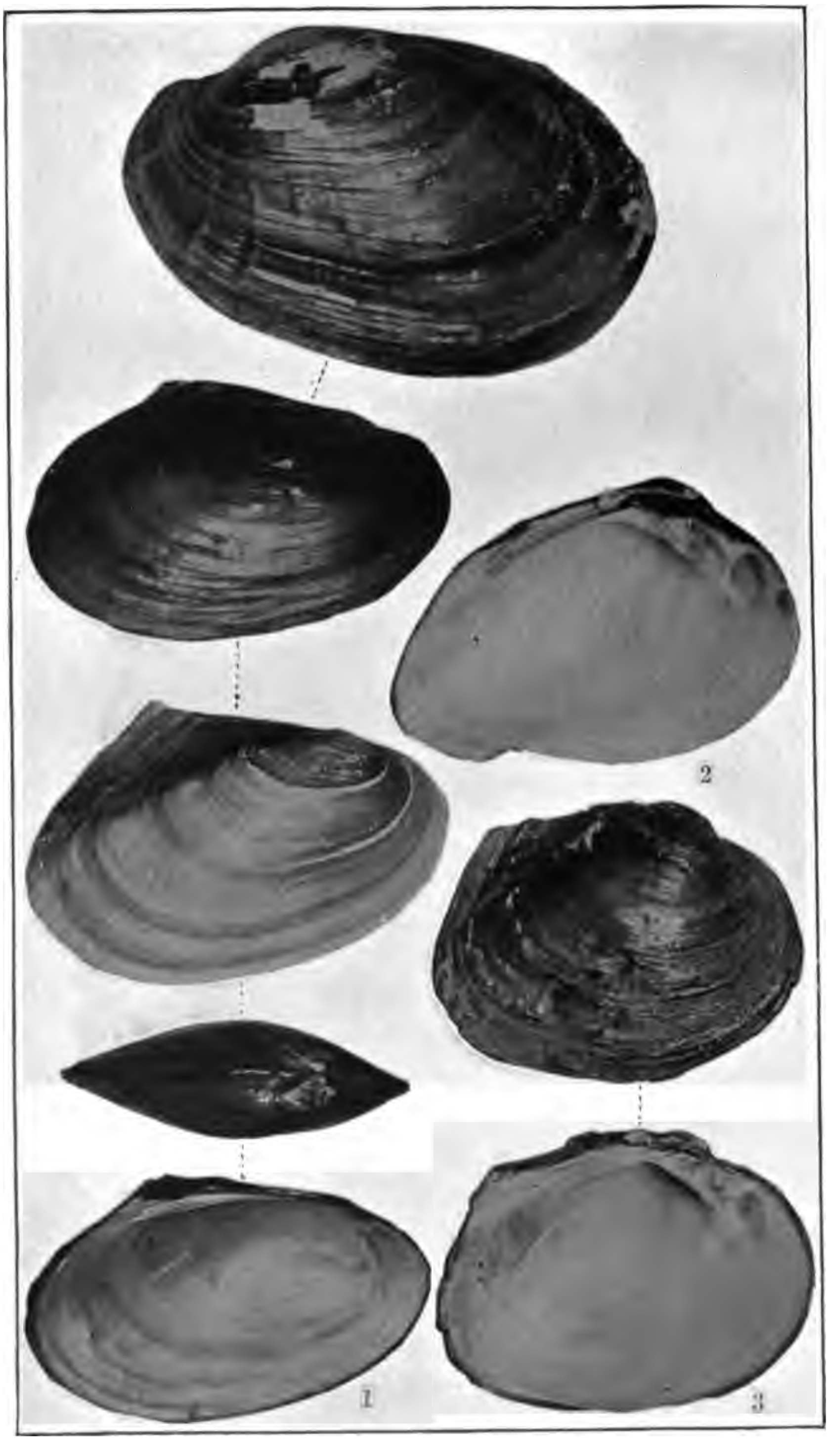


Photographed by Mrs. Amelié Walson.

EXPLANATION OF PLATE XIX.

Figure 1. Lampsilis gracilis Barnes.
" 2. Quadrula rubiginosa Lea.
" 3. Quadrula coccina Lea.
¾ natural diameter.

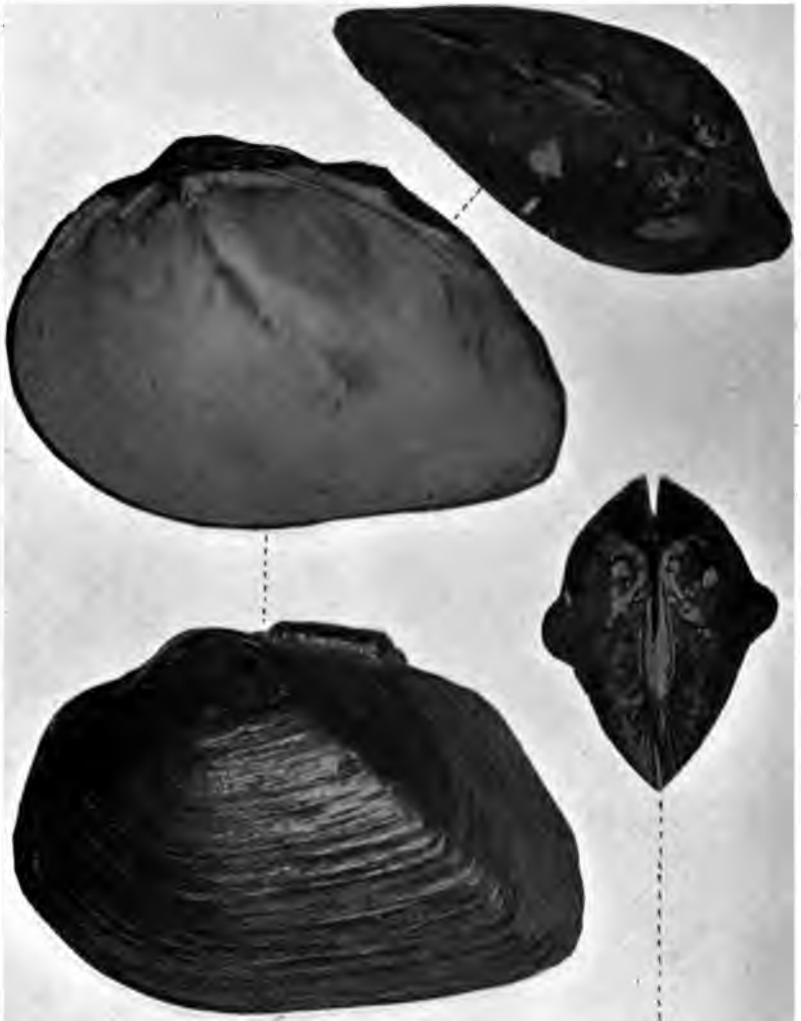
PLATE XIX.



EXPLANATION OF PLATE XX.

Figure 1. QUADRULA RUBIGINOSA Lea.
" 2. OBLIQUARIA CORNUTA Barnes.
¾ natural diameter.

PLATE XX.



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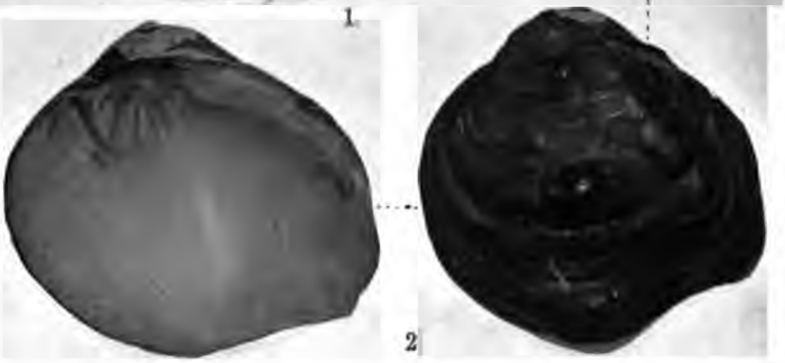

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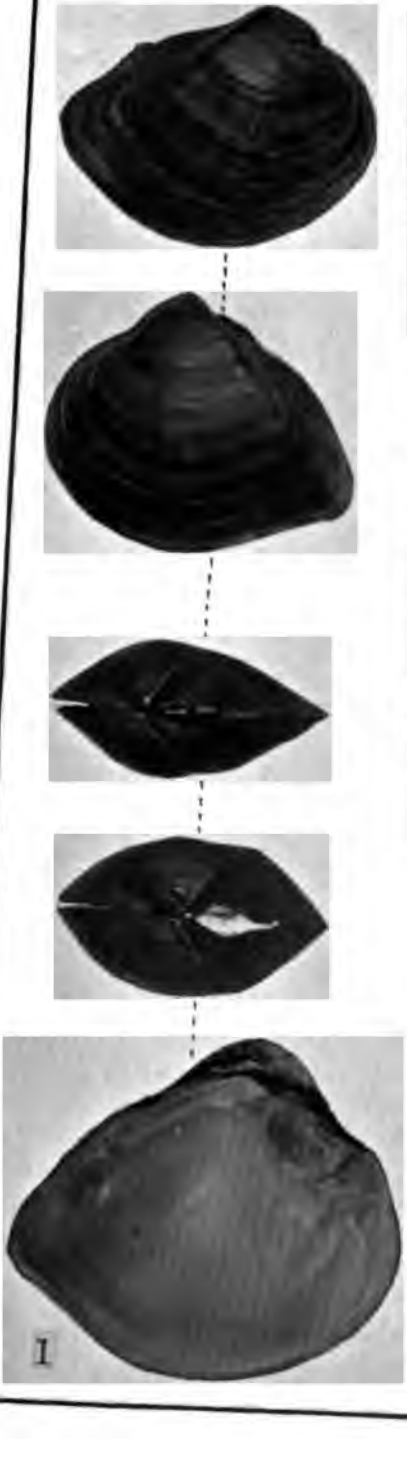
PLATE XXI



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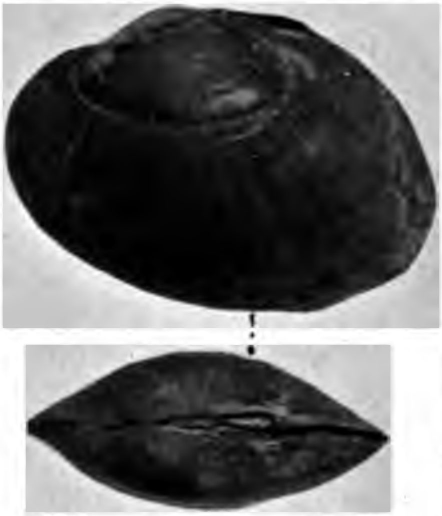

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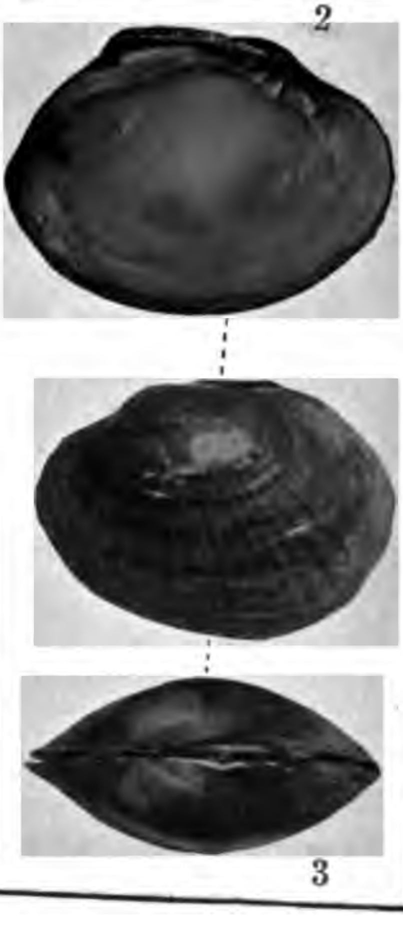
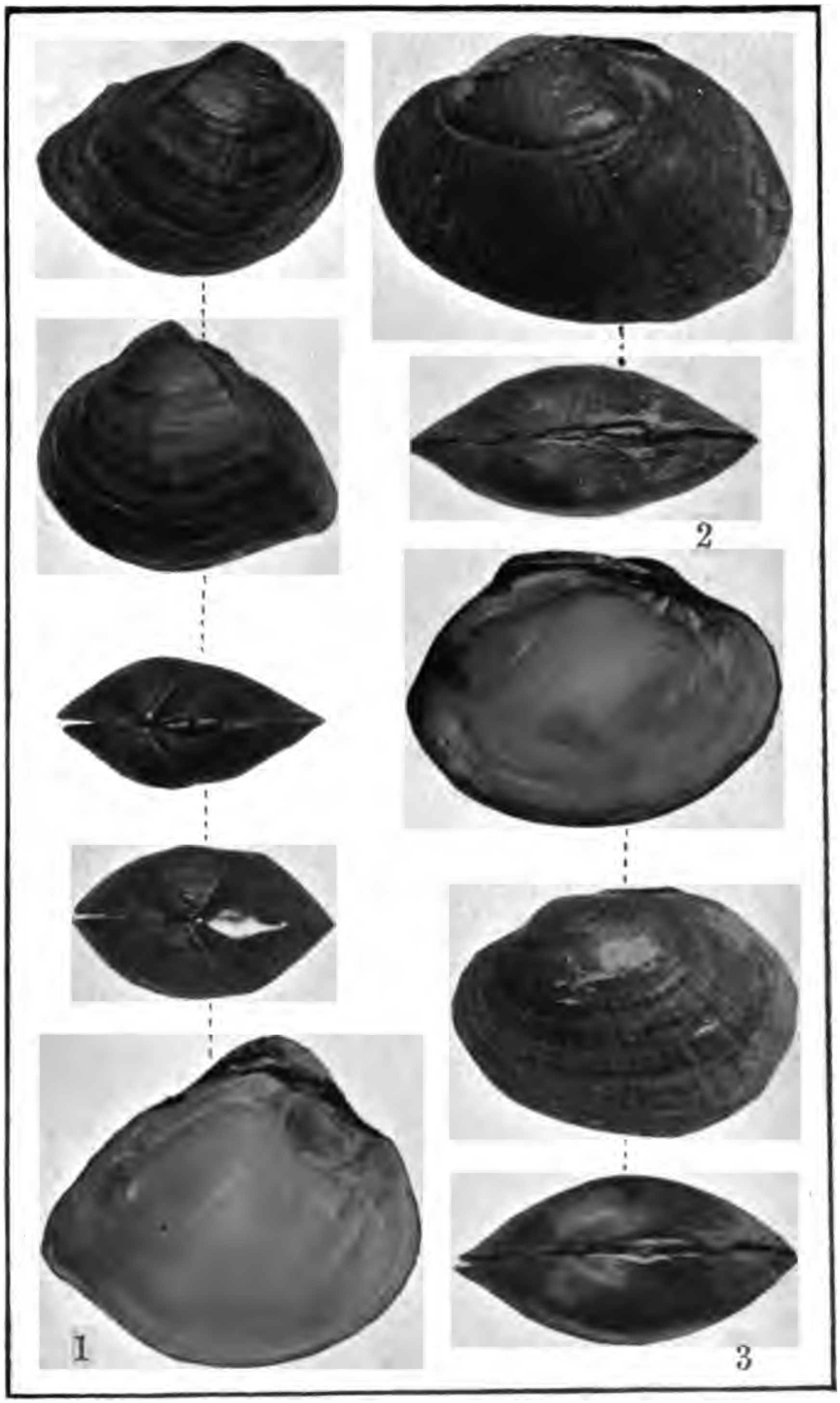


3

EXPLANATION OF PLATE XXI.

Figure 1. Plagiola elegans Lea.
" 2. Lampsilis multiradiatus Lea. ♂
" 3. Lampsilis multiradiatus Lea. ♀
¾ natural diameter.

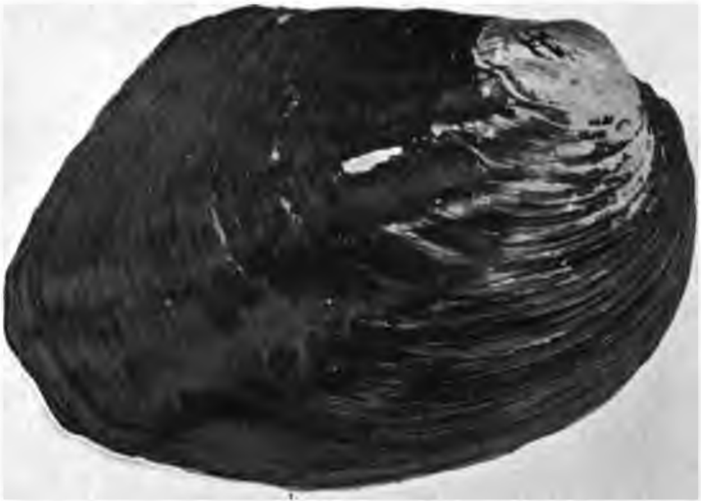
PLATE XXI.

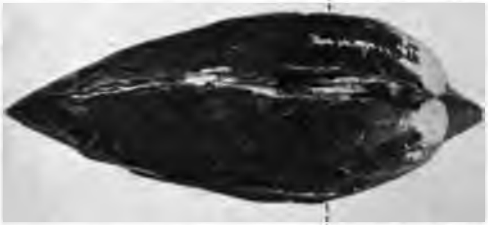


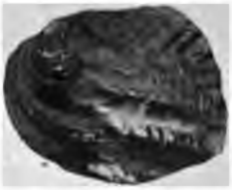
EXPLANATION OF PLATE XXII.

Figure 1. QUADRULA UNDULATA Barnes. Juvenile.
" 2. QUADRULA UNDULATA Barnes.
" 3. ALASMODONTA MARGINATA Say.
¾ natural diameter.

PLATE XXII.







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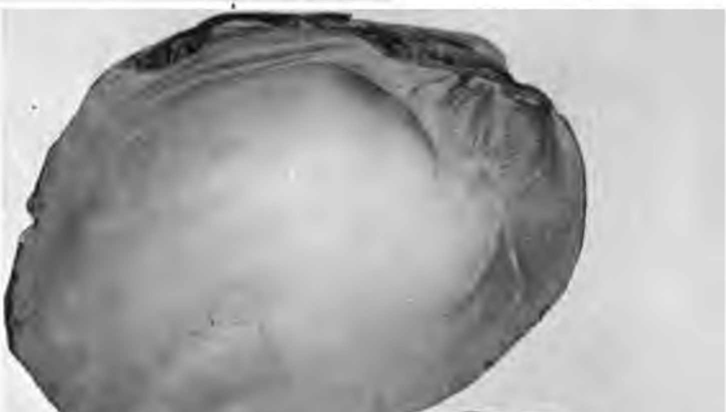

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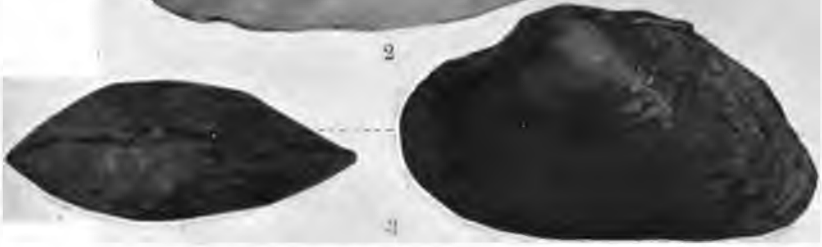

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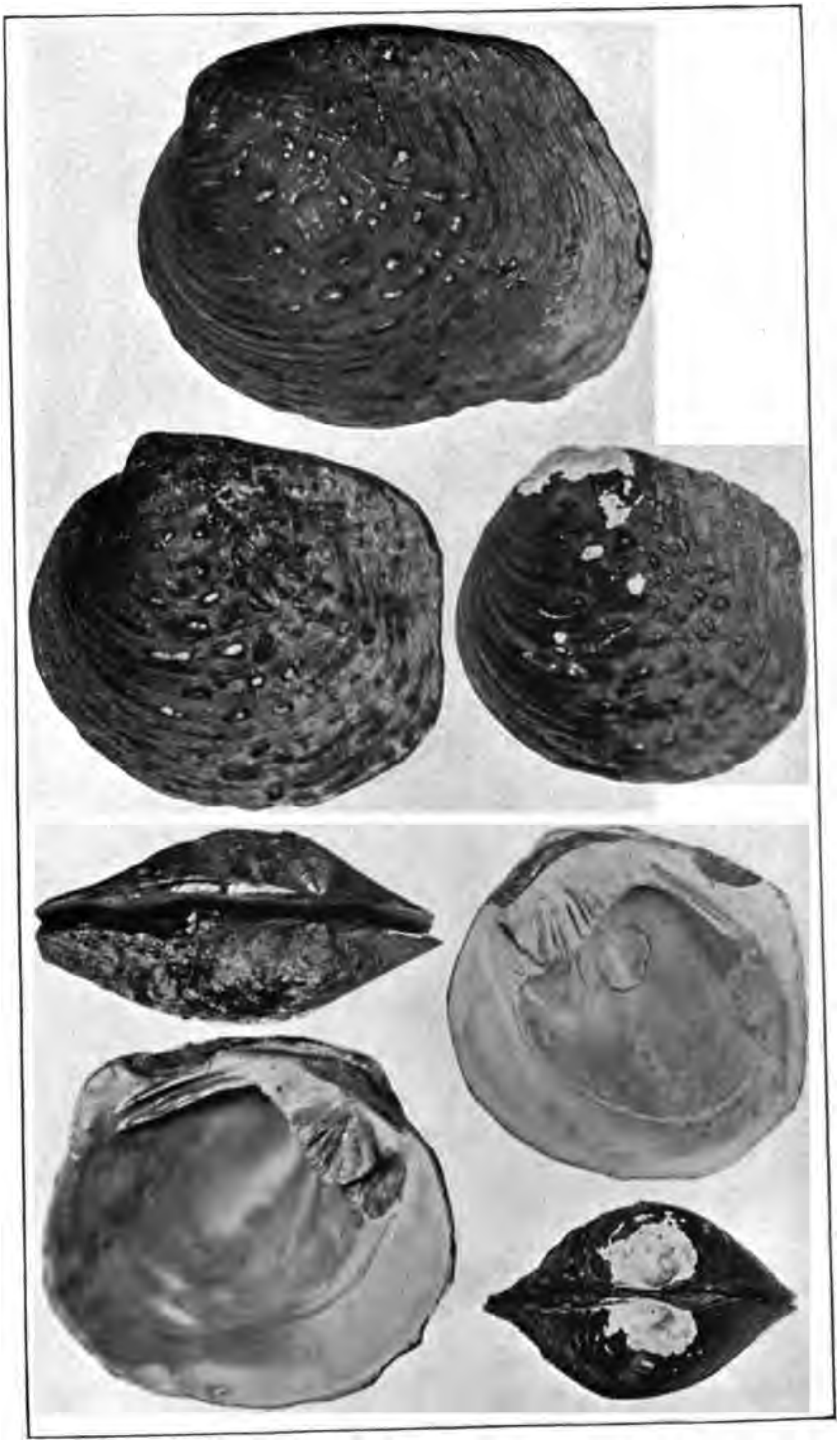
EXPLANATION OF PLATE XXIII.

QUADRULA VERRUCOSA Barnes.

¾ natural diameter.

PLATE XXIII.



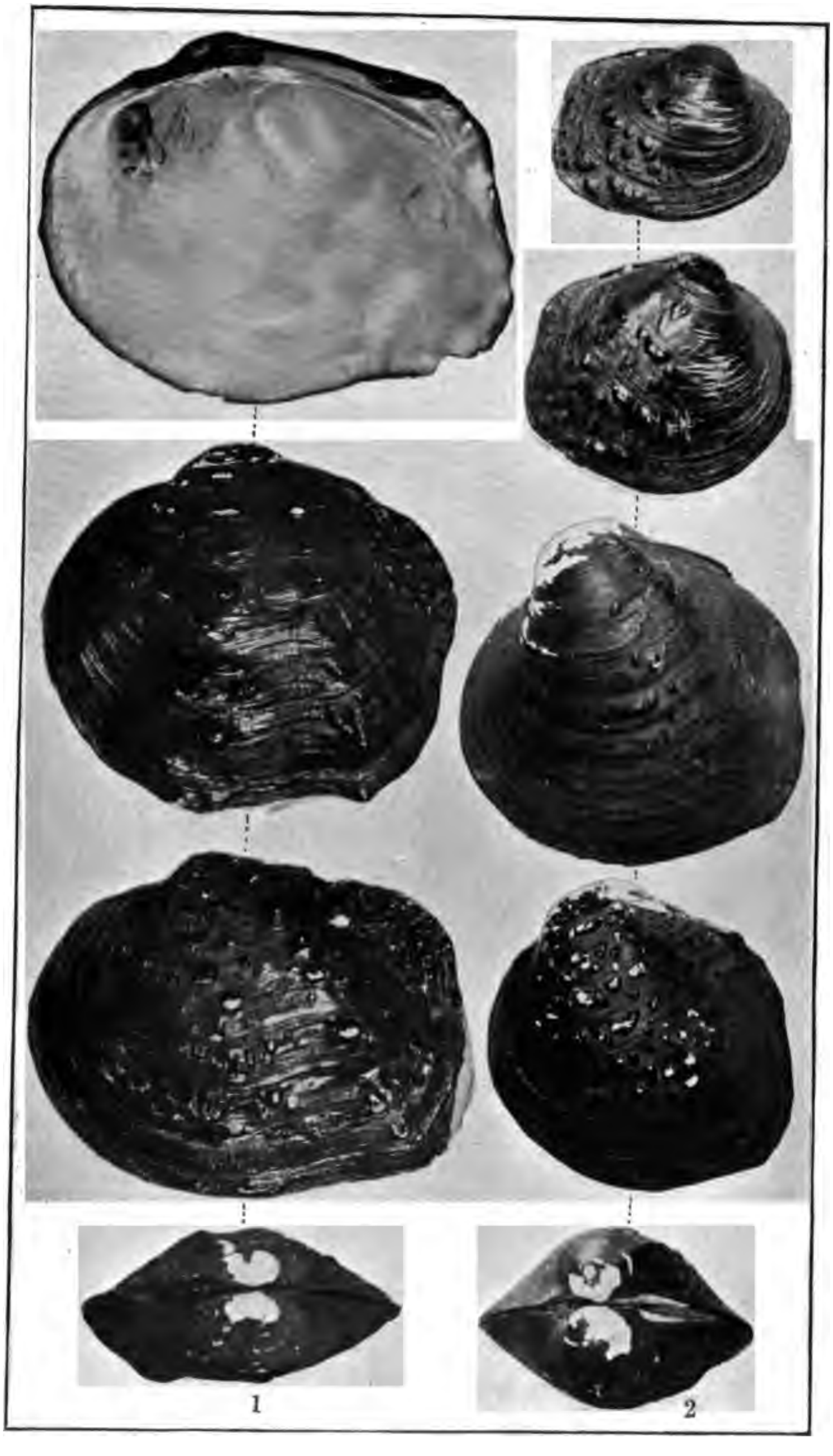
EXPLANATION OF PLATE XXIV.

Figure 1. QUADRULA LACHRYMOSA Lea.

" 2. QUADRULA PUSTULOSA Lea. Showing pustulose variation.

¾ natural diameter.

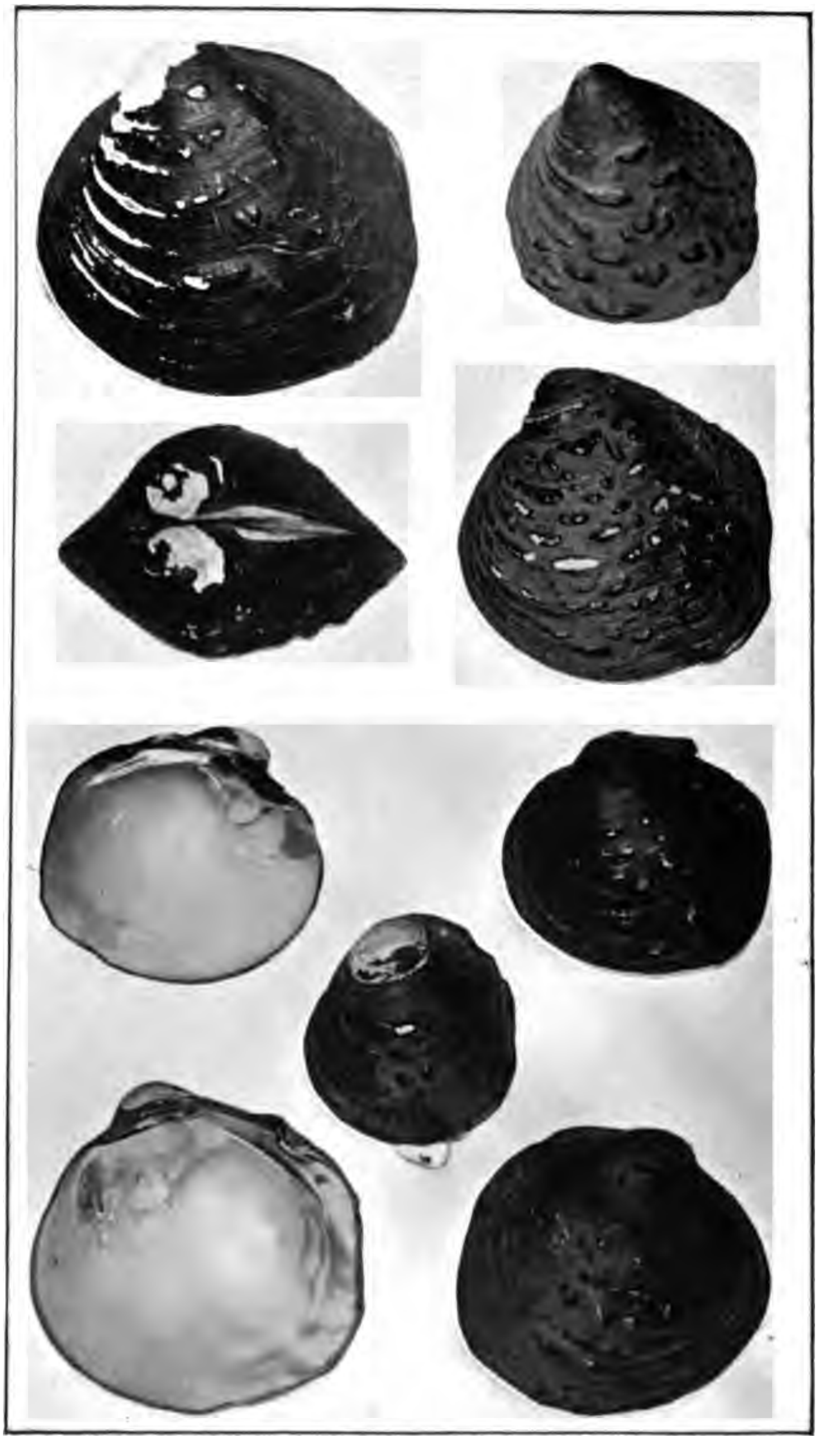
PLATE XXIV.



EXPLANATION OF PLATE XXV

QUADRULA PUSTULOSA Lea. Showing pustulose variation.
¾ natural diameter.

PLATE XXV.



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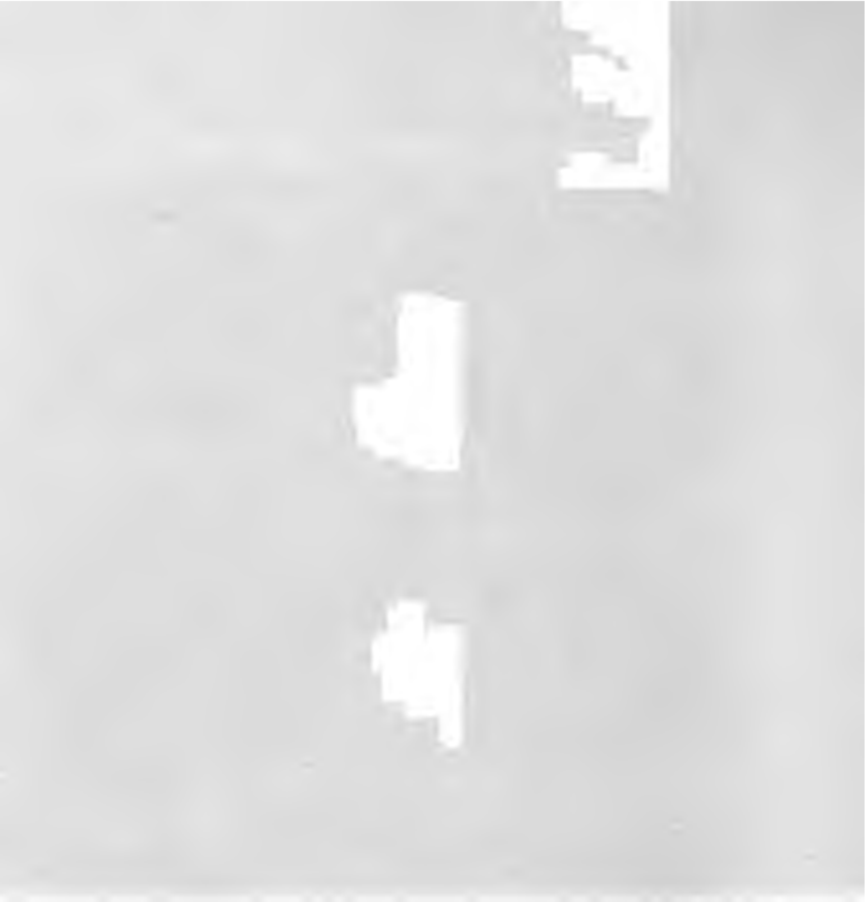


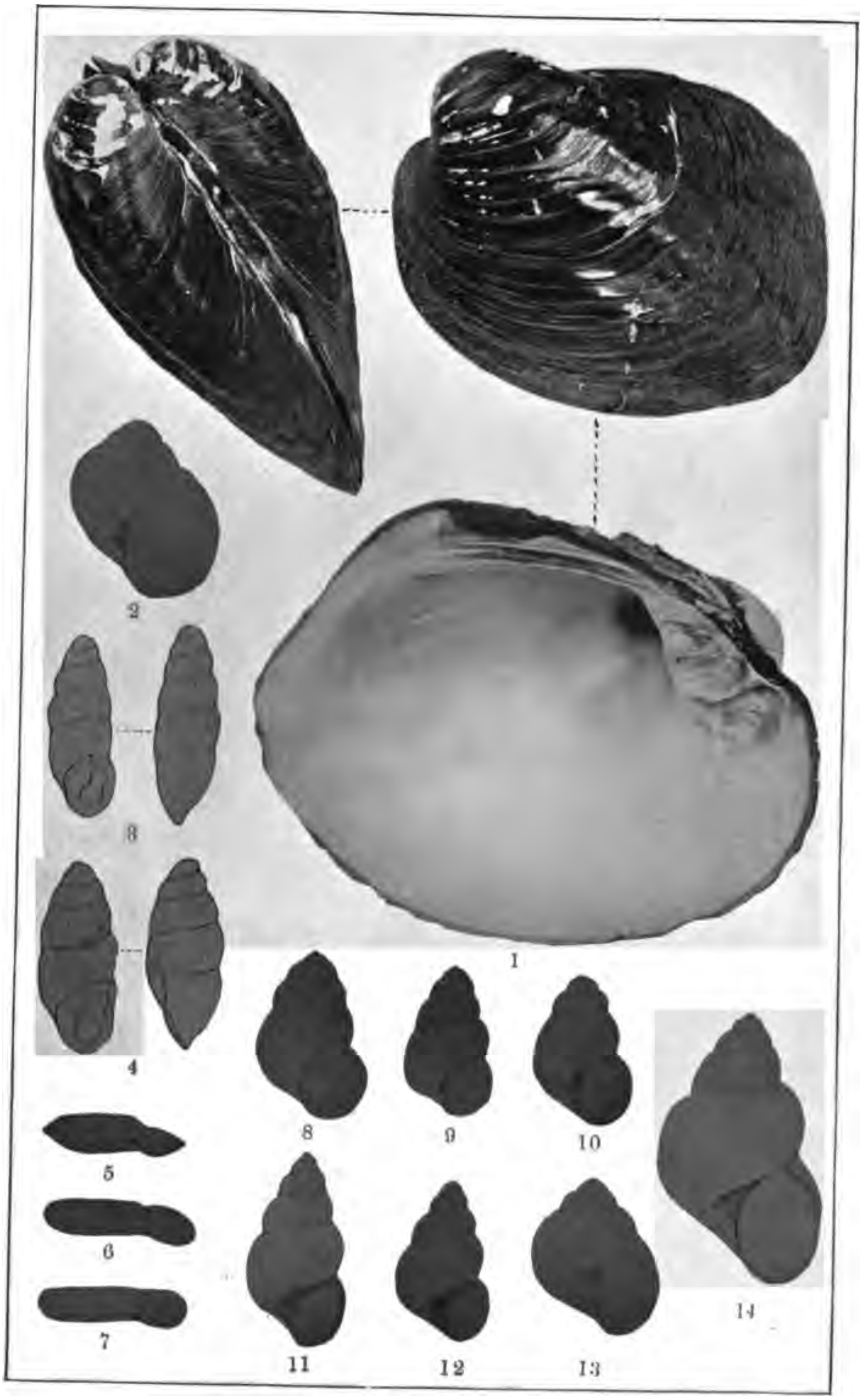
EXPLANATION OF PLATE XXVI.

Figure 1. Quadrula plicata Le Sueuer. ¼ natural diameter.

Figure 2. Somatogyrus integer Say. Enlarged.
" 3. Carychium exiguum Say. Enlarged.
" 4. Carychium exile H. C. Lea. Enlarged.
" 5. Planorbis exacutus Say. Enlarged.
" 6. Planorbis deflectus Say. Enlarged.
" 7. Planorbis parvus Say. Enlarged.
" 8. Pomatiopsis cincinnatiensis Anth. ♂ Enlarged.
" 9. Pomatiopsis cincinnatiensis Anth. ♀ Enlarged.
" 10. Cincinnatia obtusa Lea. Enlarged.
" 11. Bythinella nickliniana Lea. Enlarged.
" 12. Amnicola lustrica Pilsbry. Enlarged.
" 13. Amnicola limosa Say. Enlarged.
" 14. Cincinnatia cincinnatiensis Lea. Enlarged.

Numbers 2 to 14 are photographs of camera lucida drawings, by the author.

PLATE XXVI.

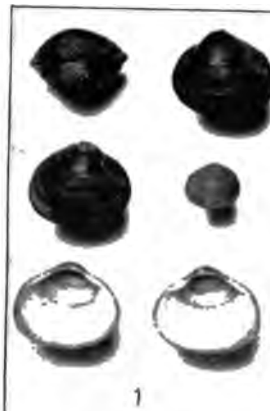


EXPLANATION OF PLATE XXVII.

Figure 1. Sphærium stamineum Conrad.
" 2. Sphærium striatinum Lamarck.
" 3. Sphærium simile Say.
" 4. Sphærium solidulum Prime.
" 5. Calyculina transversa Say.
" 6. Calyculina partumeia Say.
" 7. Sphærium fabale Prime.
" 8. Calyculina truncatum Sinsley.
" 9. Calyculina securis Prime.
" 10. Sphærium occidentale Prime.
" 11. **Alasmodonta complanata Barnes. Juvenile.**
" 12. **Anodonta grandis Say. Juvenile.**
" 13. **Quadrula pustulosa Lea. Juvenile.**

Natural diameter.

PLATE XXVII.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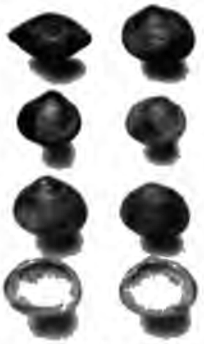
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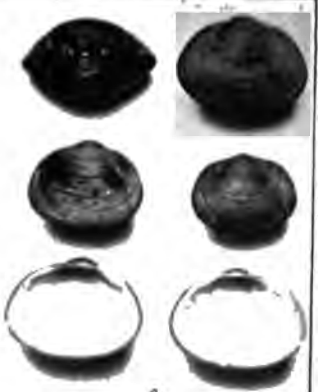
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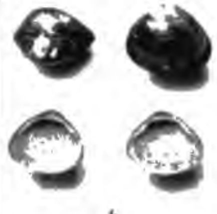
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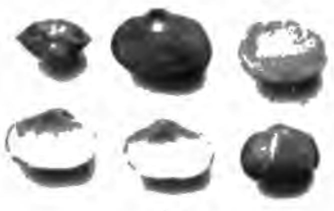
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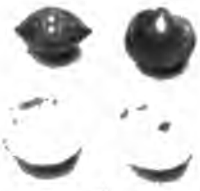
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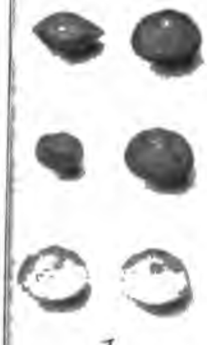
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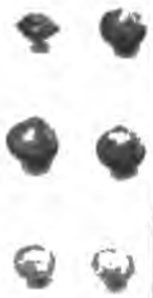
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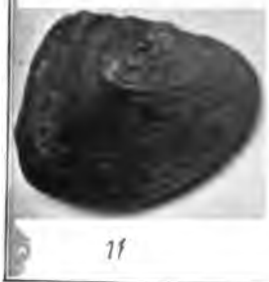
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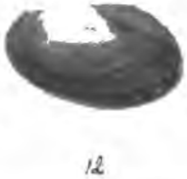
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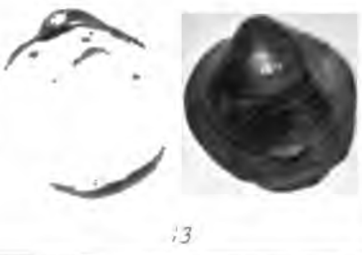
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THE CHICAGO ACADEMY OF SCIENCES

The Mollusca of the Chicago Area

BY

FRANK COLLINS BAKER
CURATOR OF THE CHICAGO ACADEMY OF SCIENCES

BULLETIN No. III.

OF

THE NATURAL HISTORY SURVEY

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Part I, THE PELECYPODA
Issued September 1, 1898.

Part II, THE GASTROPODA
Issued April 25, 1902.

LETTER OF TRANSMITTAL.

CHICAGO, ILLINOIS, November 26, 1901.

DEAR SIR:

By direction of the Board of Managers of The Natural History Survey of The Chicago Academy of Sciences, I herewith submit to you for publication, as Part II of Bulletin No. III of the Survey, the report on The Mollusca of the Chicago Area, prepared by Frank Collins Baker, Curator of The Chicago Academy of Sciences, to be issued under the rules of the Academy governing such matters.

Respectfully,

WILLIAM K. HIGLEY,
Chairman.

THOMAS C. CHAMBERLIN,
President of The Chicago Academy of Sciences.

The Board of Managers of the Geological and Natural History Survey of The Chicago Academy of Sciences:

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B. CLASS GASTROPODA.[†]

"Head distinct, usually furnished with eyes and tentacles; body mostly protected by a spiral or conical univalve shell; lower surface of animal developing a thickened, expanded, creeping disk or foot."[*]

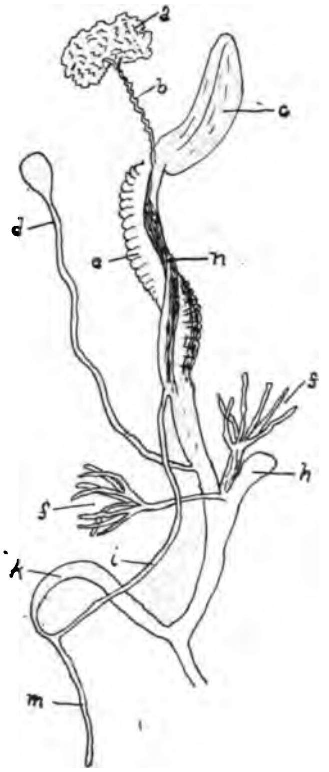

FIG. 13.

Generative apparatus of HELIX. (Semi-diagrammatic, after Lankester.) a, ovotestis; b, hermaphrodite duct; c, albuminiparous gland; d, spermatheca; e, uterine portion of hermaphrodite duct; f, f, accessory glands of female duct; h, dart sac; i, vas deferens; k, penis; m, flagellum; n, prostate gland.

The radula, which is a characteristic organ of this class, has been described on pages 41, 42 and 43 of Part I.

[†] Since considerable reference is made in the following pages to the genitalia (sexual organs), the annexed cut is introduced to explain the names of the different parts of the system of a hermaphroditic gastropod mollusk (Fig. 13).

[*] Tryon, S. & S. Conch., Vol. II, p. 99.

SUBCLASS ANISOPLEURA.

Gastropoda in which the head and feet are bilaterally symmetrical, but the visceral dome and mantle-flap, with all the containing organs, have been subjected to a rotation, bringing the anus from its posterior position to a point above the right side of the animal's neck, thus causing the shell to incline to the right side of the animal. As a result of this torsion the organs of one side become atrophied.

Superorder Euthyneura.

Gastropoda anisopleura in which the nervous loop of the viscera, being sunk below the body-wall, is not affected by the torsion of the visceral hump, but remains straight.

ORDER PULMONATA.

Gastropoda with a well-developed foot and (usually) a large, spiral shell, inoperculate (Amphibola excepted), capable of containing the entire animal; some forms, however, are without an external shell; the lungs are simple, being a pouch lined with a network of respiratory vessels; respiratory orifice small; sexes united in the same individual, but reciprocal union necessary; the genital orifices may be contiguous or distant. The lingual membrane is very variable, being in some forms short and broad and in others long and narrow; the mouth is further armed with one or more horny jaws. The Pulmonata are principally terrestrial; but several large groups are aquatic, inhabiting fresh water, while some (Auriculidæ) live in the neighborhood of the sea and follow the ebb and flow of the tide.

The pulmonates are typically vegetable feeders, although some few genera are carnivorous (Circinnaria, Glandina). They thrive best in warm, humid localities, and in desert countries are stunted in size and few in number.

The life history of a pulmonate gastropod is as follows: In May or June they lay their eggs, to the number of forty or more, in a moist locality, sheltered from the sun's rays, under old leaves or by the side of logs or stones. After about twenty or thirty days the young mollusk appears. It takes two or three years for a snail to reach maturity. In October or November the snail ceases to become active and prepares to hibernate. This it does by secreting a membrane and placing it over the aperture. The formation of this membrane (epiphragm) is as follows: "The animal being withdrawn into the shell, the collar is brought to a level with the aperture, and a quantity of mucus is poured out from it and covers it. A small quantity of air is then emitted from the respiratory foramen, which detaches the mucus from the surface of the collar, and projects it in a convex form, like a bubble. At the same moment, the animal retreats farther into the shell, leaving a vacuum between itself and the membrane, which is consequently pressed back by the external air to a level with the aperture, or even farther, so as to form a concave surface, where, having become desiccated and hard, it remains fixed. These operations are nearly simultaneous and occupy but an instant. As the weather becomes colder the animal retires farther into the shell and makes another septum, and so on, until there are sometimes as many as six of these partitions."*

During hibernation the heart almost ceases to beat, and all the functions of the body cease, the animal becoming torpid, to be awakened only when the warm days of April or May approach. The reason for hibernation is seemingly only to enable the organism to withstand the cold climate, and to exist during a period when the food supply is cut off. When kept in confinement they do not generally hibernate, but live during the winter as in the summer.

The comparative speed of snails while in motion does not seem to have been studied to any great extent. As a matter of curiosity the writer timed a few species, with the result as tabulated below:

Limnæa palustris	2	inches	in	45	seconds.
" caperata	2	"	"	50	"
" cubensis	2	"	"	50	"
" reflexa	2	"	"	35	"
Physa heterostropha	2	"	"	30	"
Vivipara contectoides	2	"	"	120	"
Polygyra profunda	2	"	"	55	"
" albolabris	2	"	"	60	"
" monodon	2	"	"	120	"
" thyroides	2	"	"	60	"
Circinnaria concava	2	"	"	90	"

SUBORDER STYLOMMATOPHORA

Tentacles four in number, the superior retractile, with eyes at their tips, and the inferior very short; animal generally terrestrial.

---

*W. G. Binney, "A Manual of American Land Shells, p. 10-11." Bull. U. S. Nat. Museum, No. 28, 1885.

Monotremata.

Common or contiguous external male and female orifice (Binney).

Sigmurethra.

Ureter abruptly reflexed from the apex of the kidney, passing to the posterior end of the lung-cavity, where an open groove or closed tube continues across to the last fold of the intestine, which it follows forward to the mantle-edge (Pilsbry).

Superfamily Holopoda.

Animal without pedal grooves; jaw always present, disinct; none of the teeth of the aculeate type (Pilsbry).

FAMILY HELICIDÆ.

"Foot-edges without pedal grooves; no tail gland. Marginal teeth with wide, short, squarish basal-plates and one or several cusps, the outer cusp never elevated on middle cusp. Shell usually with expanded or reflexed lip."*

Subfamily Polygyrinæ.

"Genitalia simple; vas deferens inserted directly on the well-developed, long penis, which has no epiphallus or flagellum; no dart sack or mucus glands; no diverticulum on spermatheca duct; eggs small and numerous. Jaw solid, ribbed or smooth; marginal teeth with more than one cusp. Shell with lip thickened within, expanded or reflexed, the embryonic whorls not distinctly differentiated."†

GENUS **POLYGYRA** (Say) Pilsbry.

Polygyra SAY, Nich. Encycl., 3d Am. ed., Vol. IV, p. 7, 1818.
Stenotrema RAFINESQUE, Amer. Mon. Mag. and Crit. Rev., Vol. IV, p. 107, 1818. (*Stenostoma.*)
Triodopsis RAFINESQUE, l. c., p. 107, 1818.
Mesodon RAFINESQUE Enumeration, etc., p. 3, 1831.
Neohelix V. IHERING, 1892.
Polygyra PILSBRY, Proc. Phil. Acad., 1889, p. 193; Guide to Study of Helices, p. 68, 1894.

---

*Pilsbry, Guide to Study of Helicis, p. XXVIII, XXXII, XXXIII, etc.

†Pilsbry, Guide to Helices, p. XXXII.

"*Shell:* Helicoid, varying from globose or depressed-globose to lens-shaped or planorboid, the periphery carinated or rounded; umbilicus either open or closed. Surface striated or hirsute; corneus, yellow or brown, generally unicolored, but sometimes with many bands, *the most constant being supra-peripheral* the others when present being wholly indefinite in number and position. *Lip well reflexed; aperture typically obstructed by the teeth*,—one parietal, two upon the lip; but *any or all teeth often wanting*."

"*Animal:* (Fig. 14). Externally as in Helix, the mantle subcentral, foot rather long and narrow, *not distinctly tripartite below*, and without longitudinal grooves above the lateral margins, although a sort of foot-margin is produced by the tessellated granulation of the edge. Surface rather coarsely irregularly granulated, the granulation finer posteriorly; back with a pair of indistinct grooves extending from mantle to facial area; *sides of foot, and sides and top of tail without any distinct oblique or longitudinal lines, irregularly granulated;* tail rounded above, obtuse behind. Mantle edges reflexed to correspond with the lip of the shell, its edge even; shell lappets none; body-lappets small, the right one long, giving off a short ascending branch behind the lung-pore; left lappet very small, short."

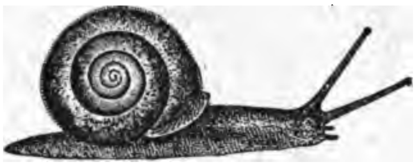

FIG. 14.

Animal of POLYGYRA. (After Binney.)

"*Genitalia: Completely lacking accessory organs;* retractor and vas deferens inserted at the apex of the penis. Spermatheca oval or oblong, *situated upon a short simple duct.* The penis is divided internally into two parts: (1) a lower, invertible portion, the inner surface of which shows few or many longitudinal folds, which are smooth and may be either weak or strong and acute; and (2) an upper portion the cavity of which has finely corrugated walls and is partly filled by one or two fleshy pillars adherent along the sides."* (Fig. 15.)

---

*Pilsbry, Guide to Helices, pp. 69 and 70; see also Proc. Phil. Acad. 1892, p. 400.

For jaw and radula see the various species described.†

Distribution: North America (exclusive of some parts of the southwestern U. S.), Cuba, Bahamas and Bermuda." (Pilsbry.)

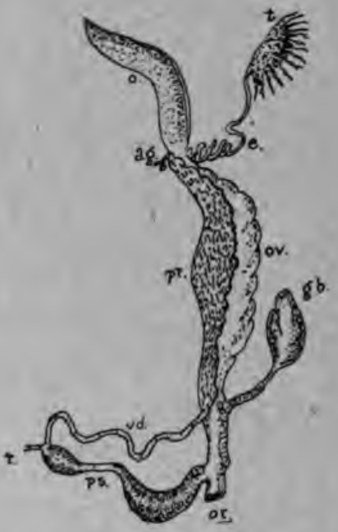

FIG. 15.

Genitalia of POLYGYRA. (P. ANDREWSI, after Binney, Bull. Mus. Comp. Zool., Vol. XI, No. 8, pl. iii, Fig. E.) ag, albuminiparous gland; e, duct from testicle; gb, genital bladder; o, ovary; ov, oviduct; or, orifice; pr, prostate gland; ps, penis; r, retractor muscle; t, testicle; vd, vas deferens.

KEY TO SPECIES OF POLYGYRA.

A. Aperture without heavily developed teeth.
  a. Shell encircled by color lines.
    1. Perforate .... *profunda*
    2. Imperforate .... *multilineata*
  b. Shell plain horn-colored.
    *Shell large.
    1. Perforate, a small denticle on the parietal wall .... *thyroides*
    2. Imperforate, globose, parietal wall toothed, aperture widely lunate .... *exoleta*
    3. Imperforate, depressed globose, tooth generally lacking, aperture narrowly lunate .... *albolabris*
    **Shell small, less than half size of (*).
    1. Perforate .... *clausa*
    2. Imperforate .... *pennsylvanica*

---

†For a general consideration of the jaws and radulæ of pulmonate mullusks, see an excellent paper by W. G. Binney in Proc. Phil. Acad., 1875, pp. 140-243.

B. Aperture with well-developed teeth.
  a. Parietal wall with one, peristome with two teeth.
    1. Perforate.
      *Spire depressed, parietal tooth depressed, curved, thin .... *tridentata*
      **Spire rather elevated, parietal tooth elevated, almost straight, thick .... *fraudulenta*
    2. Imperforate .... *inflecta*
  b. A single large tooth on the parietal wall.
    1. Imperforate; peristome notched and continuous with parietal tooth .... *hirsuta*
    2. Perforate to imperforate; peristome simple, not continuous with parietal tooth .... *monodon*

SECTION TRIODOPSIS Rafinesque.

"*Shell:* Varying from depressed to globose-conoidal, umbilicate or imperforate; surface generally striated; whorls five to six, the last wider, more or less deflexed in front. Aperture lunate, typically obstructed by three teeth, two on the lip, one on the parietal wall; but any or all of the teeth often absent." (Pilsbry, l. c., p. 74.)

51. **Polygyra inflecta** Say, pl. xxx, fig. 5.
Helix inflecta SAY. Journ., Phil. Acad., Vol. II, p. 153, 1821.
Helix clausa FERUSSAC. Tab. Syst., p. 38, No. 104; Hist., pl. xlix, fig. 2.

Shell: Depressed, solid, imperforate; surface covered with coarse striæ, the spaces between the striæ being twice or three times the width of the striæ, and the shell with numerous hair-like projections scattered over the surface; apical whorls minutely striate; periphery subangulated; sutures impressed; whorls five, convex, rather closely coiled, the last whorl considerably constricted behind the reflected peristome, so that the edge of the reflected lip is on a level with the body-whorl; spire very much depressed, slightly convex; aperture contracted, armed with three teeth; the tooth on the outer lip is tubercular and situated just below the periphery, a little deep-seated; the tooth on the basal lip is also tubercular, and placed at about the center, not deep-seated; the points of both teeth point inward, and there is a marked circular sinus between them; the parietal tooth is long, white, narrow, curved, elevated, begins at about the center of the parietal wall, and extends in an oblique direction until it meets the reflected peristome and the umbilical region; peristome thick, white, reflected; umbilicus closed, but the region indented; base of shell flat-convex.

Greater diameter 11.00; lesser, 10.00; height, 6.00 mill. (8446).

Animal: As usual in the genus; generally dark bluish or slate colored, but blackish on the head and eye-peduncles, which are long and slender; foot long and narrow, broadly rounded before and acutely pointed behind.

Jaw: Of the usual form, rather thick and broad with fourteen heavy ribs.

Radula formula $\frac{15}{2}+\frac{7}{2}+\frac{1}{3}+\frac{7}{2}+\frac{15}{2}$ (22—1—22); teeth of the same type as *tridentata*, but the inner cusps of the marginal teeth are all simple. Occasionally a stray tooth will have a bifid inner cusp, as the twentieth in one membrane and the twenty-first and twenty-third in another (vide Binney for the last).

Genitalia: "Generally resembling those of *tridentata*, but distinguished by the genital bladder, which is small, globular, on a duct of equal width throughout its course, not swelling as it approaches the vagina." (W. G. Binney.)

Distribution: Pennsylvania west of the Alleghany Mountains, west to Illinois, south to Sea Islands of Georgia, Alabama, Mississippi and Indian Territory. (Pilsbry.) Michigan. (Walker.)

Geological distribution: Pleistocene; Loess.

Habitat: Similar to that of *P. tridentata.*

Remarks: This species is at once distinguished by its aperture and closed umbilicus. It seems to be the rarest of our Helices, and it may be that the two specimens collected by Professor Higley at Miller's, Ind., were introduced from some point in Michigan. It has not yet been found in any other locality.

52. **Polygyra tridentata** Say, pl. xxx., fig. 6.

Helix tridentata SAY, Nich. Encyl., pl. ii., fig. 1, 1817, 1819.
Triodopsis lunula RAFINESQUE, Enumer., p. 3.
Polygyra tridentata juxtigens PILSBRY, Proc. Phil. Acad., p. 20, 1894 (Variety.)
Polygyra tridentata edentilabris PILSBRY, The Nautilus, Vol. VII. p. 140, 1894. (Variety.)
Polygyra tridentata complanata PILSBRY, l. c., Vol. XII., p. 22, 1898. (Variety.)
Polygyra tridentata bidentata BAKER, Trans. Acad. Sci., St. Louis, Vol. VIII., p. 85, 1898. (Variety.)
Polygyra tridentata unidentata BAKER, l. c., p. 85, 1898. (Variety.)

Shell: Depressed-globose, rather solid, umbilicated; surface covered with very heavy raised oblique striæ, the apical whorls smooth; color, horn, inclining to reddish; periphery rounded; sutures impressed; whorls, five and one-half, convex, closely coiled, the last deflected above the aperture and constricted behind the peristome; spire depressed, a little convex; aperture lunate, lobed by the teeth on the peristome; the tooth on the upper part of the outer lip is broad and low, placed squarely on the peripheral portion of the lip; the one on the basal portion of the lip is small and tubercular; the parietal tooth is of good size, elevated, narrow, oblique, and extends from the upper part of the parietal wall almost to the basal termination of the peristome; the parietal tooth is directed to a *point between the two teeth* on the outer lip; peristome reflected, white, thickened, sometimes grooved; umbilicus widely open, exhibiting all the volutions; base of shell convex (Fig. 16, A).

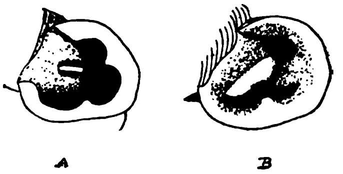

FIG. 16.

Apertures of POLYGYRA. (After Pilsbry.) A, TRIDENTATA Say; B, FRAUDULENTA. Pilsbry.

Greater diam., 15.00; lesser, 13.00; height, 7.00; umbilicus, 2.75 mill. (8447.)

Animal: As usual in the genus; color yellowish-white on foot, darker on sides of body and neck, and jet black on eye-peduncles and tentacles; mantle collar yellowish; the foot is not very long and is rather wide, and the lateral expansions are very pronounced; posteriorly it terminates rather acutely and anteriorly it is truncated; the animal appears much too small for the shell. The foot measures about 20 mill. in length and about 4 mill. in width when the animal is in motion. Heart pulsations regular, eighty-five to ninety per minute. When the animal was partly retracted within its shell the heart beat thirty-three to fifty-five times per minute.

Jaw: Arched, low, wide, ends blunt; anterior surface with eleven ribs which denticulate both margins.

Radula formula: $\frac{15}{3}+\frac{10}{2}+\frac{1}{3}+\frac{10}{2}+\frac{15}{3}$ (25—1—25). Central tooth with a rather wide base of attachment, the lower outer corners expanded and the lower margin excavated; reflection tricuspid, the center cusp long, reaching to the lower border of the base of attachment, the side cusps short; lateral teeth similar to the central tooth, but bifid, the inner cusp long and wide; marginal teeth at first resembling laterals, but the inner cusp soon lengthens, becomes bifid, and assumes the usual form of marginal.

Genitalia: "The penis sac is long, cylindrical, receiving the vas deferens and retractor muscle at its summit; genital bladder small, globular, with a long duct, which is narrow above but below its middle gradually enlarges to greater than the width of the bladder." (W. G. Binney.)

Distribution: Southern New York to Michigan, Canada to North Carolina, Alabama and Kentucky. (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: In open woodlands in the vicinity of water, under and about logs, and débris of various kinds.

Remarks: A species distinguished from *inflecta* by its open umbilicus and larger size. It is quite rare, and has thus far been found only in the southern region, and the specimens are rather small. The shell is carried at a slight angle during progression, which is rather slow.

53. **Polygyra fraudulenta** Pilsbry, pl. xxx, fig. 7.

Helix fallax W. G. BINNEY. (non Say.) Man. Amer. Land Shells, p. 292.
Polygyra fraudulenta PILSBRY, Proc. Phil. Acad. Sci., p. 20, 1894.

Shell: Differing from *tridentata* in having "a compact shell of a reddish-brown color (varying to white in some localities); the spire is low-convex, composed of six closely coiled whorls, the last being notably deflexed in front and strongly constricted behind the lip. The aperture is strongly "dished" or basin-shaped; the outer lip bears a broad tongue-shaped inflected tooth, situated at the position of the periphery of the shell. The middle part of the basal lip bears a small squarish tubercle, which is often laterally compressed. The parietal wall bears an elevated oblique blade which is typically almost straight and never much curved." (Pilsbry.) (Fig. 16, B.)

Greater diam., 15.00; lesser, 13.50; height, 8.50; umbilicus, 3.50 mill. (8448.)
" " 15.00; " 13.00; " 8.50; " 3.50 " (8455.)

Animal: As in *tridentata*, but generally a little darker.

Jaw: As usual, with twelve ribs. Binney gives fourteen ribs.

Radula formula:* $\frac{11}{3}+\frac{5}{2}+\frac{11}{2}+\frac{1}{3}+\frac{11}{2}+\frac{5}{2}+\frac{11}{3}$ (27—1—27).

---

*This radula is from a Southern Illinois specimen. See The Nautilus, Vol. XI., p. 30, 1897.

The teeth are like those of *tridentata*, excepting that there are eleven perfect laterals, and all the inner cusps are simple until the seventeenth marginal, which is bifid. Binney (Manual, p. 292) gives 40-1-40 teeth with twelve perfect laterals. The writer is certain that his count was correct, as the teeth were recounted several times, always with the same result. The membranes were perfect (Fig. 17).

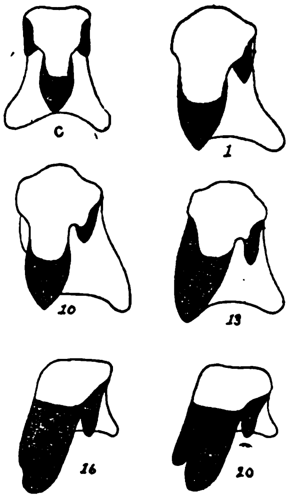

FIG. 17.

Radula of POLYGYRA FRAUDULENTA Pilsbry. (Original.) c, central tooth; 1, first lateral; 10, outer lateral; 13, first marginal; 16, 20, middle and outer marginals.

Genitalia: Similar to that of *tridentata*, but "the duct of the genital bladder is of equal size throughout its length—an unimportant, even if a constant difference." (Binney.)

Distribution: Ontario, Canada, to Michigan and Illinois, south to Georgia. (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Same as *tridentata*, and frequently associated with that species.

Remarks: This species has long been known under the name "*fallax* Say," but Professor Pilsbry has shown (l. c., p. 21), that this is not the true *fallax* of Say, that species being the *introferens* of Bland. It is easily distinguished from *tridentata* by its elevated spire and strongly armed aperture, and is more common than that species. The animal is very timid in captivity, taking a long time to come from its shell, even when immersed in water for a considerable time. When extended it will retract at the slightest jar. It does not readily crawl about, as do many of the smaller species of Polygyra, but rests half extended from its shell, twists its head about, raises its body high in the air, and constantly feels about with its eye-peduncles and tentacles. This species is found in the southern and western regions.

My friend, Mr. George H. Clapp of Pittsburg, Pennsylvania, has questioned the propriety of changing this well-known name and has offered very weighty reasons for the rejection of *fraudulenta*. With a view to prove or disprove the validity of the change I hunted up all the references to this species in American works (Tryon, the two Binney's, Pilsbry, etc.), and also carefully read the original descriptions of Say. After a careful perusal of these, and a comparison of numerous specimens, I am of the opinion that the change is valid, although Say's description is rather ambiguous. I believe the curved parietal tooth refers to *introferens* rather than to *fallax*. It is my opinion that Say had before him specimens of both *fallax* and *introferens*, and that he intended his type to be the *introferens*-like shell. It may be remarked, however, that the truth of the matter is that without the actual type, which is not now in existence, nothing can be definitely settled concerning what Say really meant by his description, as it will fit pretty well both *fallax* and *introferens*.

54. **Polygyra profunda** Say, pl. xxix, figs. 8, 10, 11.

Helix profunda SAY, Journ. Phil. Acad., Vol. II., p. 160, 1821.

Helix richardi FERUSSAC, Tab. Syst., p. 43; Hist., pl. lxx (three lower figures).

Helix bulbina DESHAYES, in Ferussac Hist., Vol. I, p. 108, pl. lxxxv, figs. 14-18. (Junior?)

Polygyra profunda alba WALKER. Terr. Moll. Mich., p. 12, 1899 (variety).

Shell: Depressed, rather solid, widely umbilicated; surface covered with numerous coarse, oblique, rib-like growth lines which are crossed by numerous very fine spiral lines; nucleus without markings; periphery rounded; sutures deeply impressed; color yellowish horn, with one well-defined brown band above the periphery, and one wide or two narrow fainter bands below the periphery; the shell may also be uniform horn-color, brown, albino, or there may be a peripheral wide band

and five or six narrow bands below and one or two above the peripheral band; whorls six, convex, rapidly increasing in size; aperture very nearly circular; somewhat contracted by the reflected peristome, and showing the bands of color through the shell; peristome reflected, very thick, white or pinkish, with an obtuse tooth on the base; terminations deflected toward each other and connected, in some specimens, by a thin callus; the reflection near the columella partly covers the umbilicus; umbilicus profound and wide, showing all the volutions to the apex, which may be easily perforated; base of shell convex.

Greater diam.,	29.00;	lesser,	25.00;	height,	15.50;	umbilicus,	5.00	mill.	(10118.)
" "	30.00;	"	25.50;	"	15.50;	"	5.00	"	(7731.)
" "	26.00;	"	21.50;	"	15.50;	"	5.00	"	(7730.)
" "	31.50;	"	25.50;	"	14.50;	"	6.00	"	(7729.)

Animal: With a long and narrow body; color light brown, darker on eye-peduncles and head, upper surface of foot flecked with white; foot thick, long, narrow, acutely pointed behind; eye-peduncles long and slender, cylindrical, the black eyes on prominences at the tip; tentacles short, cylindrical, blunt; respiratory orifice large, on the right side under the peristome. The heart is plainly seen just below the largest brown band and about 5 mill. from the aperture. An examination of the pulsations of a dozen individuals gave the following data: 70 (3 specimens), 65 (4 specimens), 62 (3 specimens), 58 (1 specimen), 56 (1 specimen). The heart beat much slower when the shell was held tightly in the hand, and much faster (70) when the animal was extended and crawling over the hand. Length of foot 41.00 mill., width 10.00 mill. Another specimen gave 57 by 11 mill.

Jaw: Strongly arched, ends squarely truncated; ten stout ribs on anterior surface which denticulate both margins of jaw (Fig. 18).

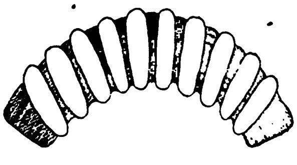

FIG. 18.
Jaw of POLYGYRA PROFUNDA Say. (Original.)

Radula formula: $\frac{26}{2}+\frac{14}{3}+\frac{1}{3}+\frac{14}{3}+\frac{26}{3}$ or $\frac{28}{2}+\frac{12}{3}+\frac{1}{3}+\frac{12}{3}+\frac{28}{2}$ (40—1—40); central tooth with a squarish base of attachment, much expanded on the lower outer edges; reflected portion with three cusps, of which the central one is very long and the side cusps are (generally) subobsolete, the cutting points well developed; lateral teeth similar to the central tooth, but with side cusps distinct; marginal teeth with a small base somewhat quadrangular in shape, and with irregularly shaped cusps, the inner being several times longer and broader than the outer cusp; both have well developed cutting points. The transition from lateral to marginal teeth is very gradual, and it is difficult to determine just where one set ends and the other begins (Fig. 19). Several teeth in one membrane examined (37–1–37) had the inner cusp bifid (27–32 in figure). Mr. Binney says: "but the change from laterals to marginals is very gradual, being made without splitting of the inner cutting point, which is simple on the extreme marginals even."*

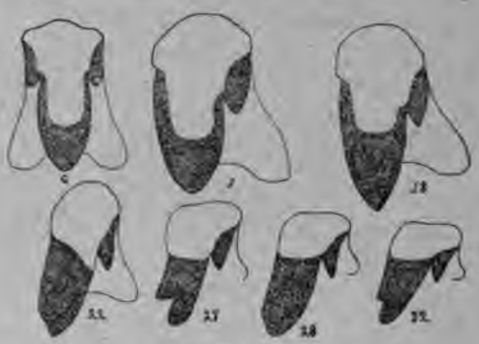

FIG. 19.

Radula of POLYGYRA PROFUNDA Say. (Original.) c, central tooth; 1, first lateral; 18, intermediate lateral; 22, 27, 28, 32, marginal teeth.

This membrane was undoubtedly a pathological specimen. There are over 120 rows of teeth.

Genitalia: "The penis sac is not very stout, long, receiving the retractor muscle at about the middle of its length, and tapering very gradually towards its summit into the vas deferens; genital bladder large, globose-oval, on a long, narrow duct." (W. G. Binney.)

Distribution: Western New York to Minnesota, south to Virginia and Mississippi.

Geological distribution: Pleistocene; Loess.

Habitat: Found in large numbers in woodlands where there is moisture, under dead underbrush and old logs.

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*Manual Amer. Land Shells, p. 318.

Remarks: Profunda closely resembles *multilineata* Say when both are young, being umbilicated and with numerous spiral color lines. In *multilineata* the band just above the periphery is narrow, while in *profunda* it is very wide. When adult the former is *imperforate* while the latter is *widely umbilicated.* This is one of our most abundant mollusks, and is the finest and largest of the Helices in this region. It is very bold in captivity, allowing its captor to pick it up without retracting into its shell. If the term could be applied to mollusks, I should say that it was of an inquisitive turn of mind, for it investigates everything within reach. A single specimen (Pl. xxix, Fig. 8) was found at Wolf Lake by Prof. W. K. Higley, in 1888, which is very curiously distorted; the superior part of the peristome, near the body-whorl, is very much bulged, and the lip at this point projects in a tooth-like manner; the periphery, from the aperture to a point half way around the last whorl, is concave, or grooved. The animal must have suffered some injury, probably from the pressure of some foreign object. This is, next to *Pyramidula alternata,* our most common species, and is found everywhere. It may be collected in the Bowmanville woods by hundreds, about old moss-covered logs, and particularly about old camp-fires where there is some charred wood It varies greatly in coloration, from light colored to very dark with a wide band.

54a. Polygyra profunda alba Walker.

Polygyra profunda alba WALKER, Terr. Moll. Mich., p. 12, 1899.

The variety differs from the type in being pale horn colored without bands. Variety *alba* is not common in this region, and has been found only at Joliet and Bowmanville.

55. Polygyra albolabris Say, pl. xxix, fig. 6.

Helix albolabris SAY, Nich. Encyl., Am. ed., pl. i, fig. 1, 1817.

Helix major BINNEY, Bost. Journ. Nat. Hist., Vol. I, p. 473, pl. xii, 1837. (Variety.)

Helix rufa DE KAY, N. Y. Moll., p. 44, pl. iii, fig. 30, 1843. (Vide W. G. Binney.)

Polygyra albolabris maritima PILSBRY, The Nautilus, Vol. V, p. 142, 1892. (Variety.)

Helix transversensis LEACH, Mss., The Nautilus, Vol. XI, p. 94, 1898.

Polygyra albolabris minor STERKI, Land & Fr., W. Moll., Tuscar. Co., Ohio, p. 2. (Variety.)

Polygyra albolabris alleni WETHERBY, The Nautilus, Vol. XI, p. 94, 1898.* (Variety.)

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*The original reference to this variety has not been found in any work to which the author has access. This is also true of *P. thyroides pulchella* ckll.

Shell: Depressed globose, rather solid, imperforate; surface covered with numerous fine, oblique striæ which are obsolete on the apical whorls, and the whorls are encircled by very numerous fine, wavy, spiral lines, which give the surface a latticed aspect under the glass; color yellowish-brown, sometimes darker, without bands; periphery rounded; sutures much impressed; whorls five to six, rounded, regularly increasing; spire but little elevated; aperture lunate, contracted by the peristome; peristome widely reflected, white, flattened, with sometimes a small callosity near the columella, which is nearly straight; umbilicus covered in the adult shell by the reflection of the peristome, which forms a spreading callus; base of shell convex.

Greater diameter, 32.00; lesser, 26.00; height, 19.00 mill. (7972.)
" " 30.00; " 24.50; " 18.00 " (8091.)

Animal: With a long foot which is wide and spreading at the base, and slopes up to meet the rounded body and neck; posterior extremity of foot flattened and spreading, acutely pointed, and rising to meet a central dorsal keel. Color yellowish-brown, with a dark stripe extending down the center of the neck and head to the shell; tentacles and eye-peduncles almost black; sometimes darker along sides of body; the animal is sometimes whitish or cream-colored, and may be almost black. Eye-peduncles very long, bearing the black eyes; tentacles short and cylindrical, tubercles on the back very prominent and arranged longitudinally. The foot of a large specimen measured 60 mill. in length and 14 mill. in width, and the eye-peduncles measured 13 mill. in length. The heart pulsations are as follows: 50-56-61 (adult); 69 (half-grown); 106 (very young); 48 (animal dormant).

Radula formula: $\frac{19}{3}+\frac{15}{2}+\frac{10}{1}+\frac{1}{1}+\frac{10}{1}+\frac{15}{2}+\frac{19}{8}$ (44—1—44) (sometimes 45—1—45). Central tooth with a long and narrow base of attachment, the lower outer corners expanded and the base excavated; reflection reaching below the margin of the base of attachment, with the cusps similar to those of *tridentata*, but narrower; lateral teeth similar to central; marginal teeth at first like lateral teeth, but soon (28) the inner cusp becomes bifid, the cusp becomes wider (30—35) and extends far below the base of attachment. Thirty-eight is a marginal of abnormal form; one row had all of the thirty-eighth teeth of this form (Fig. 20). There are over 120 rows of teeth.

Jaw: Similar to that of *thyroides*, but very arcuate and with ten ribs of somewhat unequal size. The ends of the jaw are smooth on their anterior surface.

Genitalia: "The penis sac is stout, rather short, cylindrical, with a median prepuce; it receives the vas deferens at its summit; the retractor muscle is inserted on the vas deferens near its junction with the penis sac; the genital bladder is long, stout, blunt at its summit; its duct is very narrow at its entrance into the bladder for a short portion of its course, then becomes suddenly expanded into very much the shape and still greater size of the bladder."[*] This peculiar arrangement of the genital bladder and duct distinguishes *albolabris* from all related species.

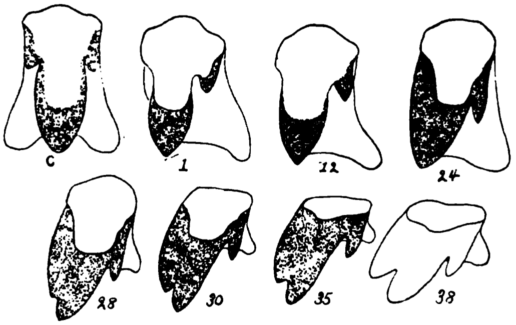

FIG. 20.

Radula of POLYGYRA ALBOLABRIS Say. (Original.) c, central tooth; 1, first lateral; 12, twelfth lateral; 24, 28, first marginals; 30, 35, outer marginals; 38, abnormal marginal.

Distribution: Canada, Eastern and Central United States.

Geological distribution: Pleistocene; Loess.

Habitat: Found under and about old logs in open woodlands, and in wet weather crawling over the vegetation.

Remarks: Distinguished by its large size, imperforate base, and white lip. This is our largest and handsomest snail, and is found only in the southern and western regions. The animal is slow in movement, but not at all timid, readily allowing itself to be handled without withdrawing into its shell. When crawling up the side of a glass jar the shell is so heavy that it hangs almost to the extremity of the foot. The eye-peduncles are pointed straight ahead during locomotion, the shell is carried almost flat, and the tentacles are directed straight downwards. When eating, the head is drawn partly in and the tentacles are laid back and half contracted. The writer timed a large specimen of this species and found that it progressed 24 inches in 14 minutes.

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[*] W. G. Binney, Man. Amer. Land Shells, p. 300.

55 a. **Polygyra albolabris dentata** Tryon.
Mesodon dentata TRYON, Man. of Conch., Vol. III., p. 150.

Differs from *albolabris* in possessing a tooth on the parietal wall. The variety is rare, but is found associated with the type in all localities.

56. **Polygyra exoleta** Binney, pl. xxix, fig. 5.
Helix exoleta BINNEY, Terr. Moll. U. S., Vol. II, p. 131, pl. x.
Helix zaleta BINNEY, Bost. Journ. Nat. Hist., Vol. I, p. 492, pl. xx.

Shell: Globose, solid, imperforate: surface shining, marked by numerous fine, oblique growth lines, which are faintly marked on the apical whorl; the growth lines are crossed by very fine spiral lines as in *albolabris;* color yellowish, sometimes dark horn; periphery rounded; sutures well impressed; whorls five to six, globose, the last ventricose, rather closely coiled; spire a little elevated, convex; aperture roundly lunate, contracted by the body-whorl, the base of the aperture forming an angle with the base of that portion of the body-whorl contracting the aperture; peristome broadly reflected white, sometimes a trifle grooved, with a small callosity near the base, terminations separated and connected by a thin callus; parietal wall armed with a long, narrow tooth or denticle about midway between the terminations of the peristome; umbilicus covered (in the adult shell) by the white reflection of the peristome; base of shell rounded.

Greater diameter, 24.00; lesser, 21.50; height, 16.50 mill. (7973.)
" " 27.00; " 22.00; " 19.00 " (7973.)
" " 28.00; " 23.00; " 20.00 " (8092.)

Animal: Resembling *albolabris* in general form. Color dirty white or yellowish-white, darker above; eye-peduncles jet black, a light zone surrounding the eyes; tentacles yellowish-white at base and black at tip; mantle yellowish-white; the animal may also be brownish or blackish.

Heart situated near the upper junction of peristome with body-whorl: pulsations quite regular, seventy-five to seventy-seven per minute.

Jaw: Of usual form, rather narrow, arcuate, attenuated at the ends; thirteen ribs present.

Radula formula: $\frac{4\ 6}{2+4}+\frac{8}{2}+\frac{6}{1}+\frac{1}{1}+\frac{6}{1}+\frac{8}{2}+\frac{4\ 6}{2+4}$(60—1—60);

central tooth long and rather narrow, base of attachment excavated on the lower border; reflection long and narrow, unicuspid, but there are side bulgings representing the side cusps; first six lateral teeth similar to central tooth, but wider; next seven teeth with a small outer wide cusp; the fourteenth tooth has a bulging on the lower part of the inner cusp; from this point the teeth become narrower to the forty-second tooth, when they widen and develop an inner small cusp and two outer side cusps; the marginals are very variable, and the outer side cusps may or may not be developed; the forty-first tooth was very peculiar on a membrane having but 47–1–47 teeth (some of the marginals probably torn away), and this tooth was found on all the rows of teeth and on both sides of the membrane. The outer cusp of the lateral teeth is very variable. Binney found eleven perfect laterals, but remarked that the eighth tooth showed some modification (Fig. 21).

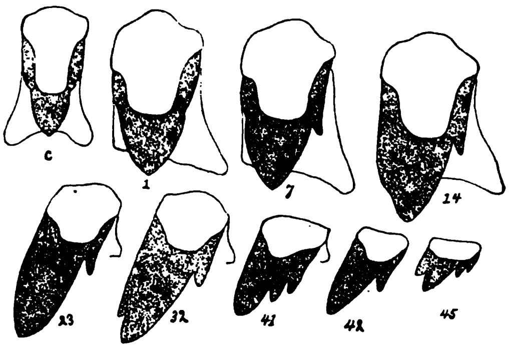

FIG. 21.

Radula of POLYGYRA EXOLETA Binney. (Original.) c, central tooth 1, first lateral; 7, lateral tooth, showing appearance of outer cusp; 14, marginal tooth; 23, 32, intermediate marginal teeth; 41, 42, 45, outer marginal teeth.

Genitalia: "The penis sac is very stout, long, cylindrical, receiving the retractor muscle and vas deferens at its summit; genital bladder subconical, on a short, small duct; the vas deferens is convoluted as it leaves the prostate." These organs are specifically distinct from those of *albolabris*, and serve as a sure method of distinguishing the two species.

Distribution: Western New York west to Iowa, Michigan south to Alabama and Georgia.

Geological distribution: Pleistocene of central United States; Loess.

Habitat: Same as that of *albolabris*.

Remarks: The present species very closely resembles *albolabris*, but differs in its smaller, more globose shell, the almost universal presence of the tooth on the parietal wall and the less contracted and rounded aperture. The two species are almost always found associated together. The shell is carried sightly tilted over the back during locomotion. This species is found only in the southern and western regions.

57. **Polygyra thyroides** Say, pl. xxix, figs. 2, 7.

Helix thyroides SAY, Nich. Encycl., Am. ed., 1817, 1818, 1819; Jour. Phil. Acad., Vol. 1, p. 123, 1817.

Helix bucculenta GOULD, Proc. Bost. Soc. Nat. Hist., Vol. III, p. 40, 1848. (Variety.)

Polygyra thyroides pulchella CKLL. The Nautilus, Vol. XI, p. 95, 1898, (Variety.)

Polygyra thyroides sanctisimonis Pilsbry, The Nautilus, Vol. XV. p. 8, 1901. (Variety.)

Shell: Depressed, thin, umbilicated; surface covered with numerous crowded, oblique lines of growth which are crossed by very fine spiral lines; the nuclear whorl is almost smooth; color light yellowish, brownish, horn color or russet, sometimes inclined to pinkish; periphery rounded; sutures well impressed; whorls five, depressed-globose, rapidly increasing in size; spire somewhat elevated; aperture lunate, spreading, contracted by the peristome; peristome widely reflected, thin, grooved, white, terminations connected by a thin callus; parietal wall with a more or less well developed, white tooth, which is longer than wide, placed obliquely to the plane of the aperture; columella flexuous; umbilicus open, partly covered by the reflected peristome; base of shell rounded.

Greater	diameter,	28.00;	lesser,	23.00;	height,	18.00	mill.	(9920.)
"	"	28.00;	"	22.00;	"	16.00	"	(8404.)
"	"	26.00;	"	21.25;	"	17.00	"	(10668.)
"	"	24.50;	"	21.00;	"	16.50	"	(7733.)
"	"	21.50;	"	18.00;	"	15.00	"	(8374.)

Animal: Grayish or yellowish-white, darker on the head and eye-peduncles, dirty white on base of foot; eye-peduncles long, tapering, thin, eyes black; foot long and narrow, the length of a good-sized individual being 43 and the width 5 mm.; the posterior extremity of the foot terminates in an acute angle; the heart is situated near the junction of the upper part of the peristome with the body-whorl; the pulsations are irregular and number from seventy to seventy-three when the animal is drawn into its shell, but become regular and number eighty-two when the animal is extended. One specimen gave eighty-eight beats in a minute.

Jaw: Very long and narrow, slightly arcuate, the ends knob-shaped; the anterior and posterior surfaces are armed with thirteen stout ribs which denticulate both dorsal and ventral margins (Fig. 22).

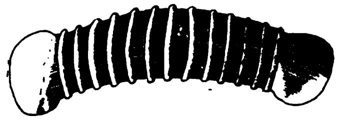

FIG. 22.

Jaw of POLYGYRA THYROIDES Say. (Original.)

Radula: With 58–1–58 teeth; central tooth with a long and narrow base of attachment, laterally expanded at the lower outer corners; reflection as long as base, unicuspid, the cusp being long and narrow; lateral teeth similar to centrals but asymmetrical (eleven perfect laterals); marginal teeth at first similar to laterals, but soon the cusp elongates, an outer side cusp is developed, the larger cusp becomes bifid, and toward the end of the membrane the marginals become short and wide and two outer side cusps appear. All of the cusps are provided with very long and stout cutting points (Fig. 23).

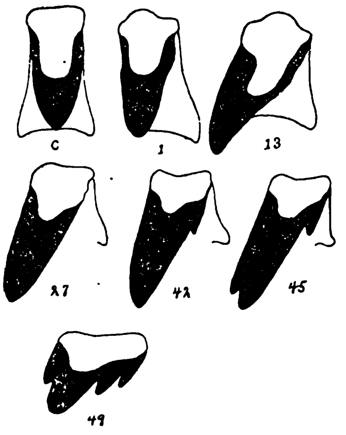

FIG. 23.

Radula of POLYGYRA THYROIDES Say. (Original.) c, central tooth; 1, first lateral; 13, second marginal; 27, sixteenth marginal; 42, 45, thirty-first and thirty-fourth marginals, 49, thirty-eighth marginal.

Genitalia: "The penis sac is short, stout, cylindrical, receiving the vas deferens and retractor muscle at its summit; the genital bladder is small, elongated, bluntly tapering at its apex, on a short, narrow duct; the oviduct is greatly convoluted." (W. G. Binney, l. c.)

Distribution: Canada to Minnesota, south to St. Simons Islands, Georgia, and Texas. (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Found under rotten logs and pieces of wood in forests where there is more or less moisture, particularly near the edge of the woods. On rainy days or just after a rain, it may be seen crawling over the ground, on tree trunks, etc.

Remarks: *Thyroides* is distinguished from all others of the group by its open umbilicus, thin, spreading peristome and wide aperture. The parietal tooth is frequently wanting, and a variety of the *bucculenta* form is imperforate. In habits the animal varies, some specimens being shy in captivity and requiring a great amount of persuasion to induce them to crawl over the hand or on a table; other individuals are bold and will readily crawl over the extended hand, and will even allow themselves to be picked up by the shell without withdrawing into it. It is found in all parts of the area.

58. Polygyra clausa Say, pl. xxix, fig. 4.

Helix clausa SAY, Journ. Phil. Acad., Vol. II, p. 154, 1821.

Helix ingallsiana SHUTTLEWORTH, Fischer's Notitiæ, Vol. II, pl. iii, fig. 5.

Shell: Semi-globose, varying from thin to rather solid, umbilicated; surface with very numerous crowded, oblique, rib-like lines of growth, crossed by numerous fine spiral lines; the nuclear whorl is smooth; color yellowish to greenish-horn; periphery broadly rounded, sutures deeply impressed; whorls five to five and one-half, rounded, convex, rather closely and regularly increasing, the last a little spreading; spire varying from somewhat depressed to elevated and sub-conical; aperture diagonally lunate, expanded above, narrowed below, the columella a trifle dilated; peristome contracted behind the narrowly reflected portion, which is white and rounded in old specimens; the terminations widely separated and connected by a very thin callus; umbilicus of good size, partly covered by the reflected columellar portion of the peristome; base of shell rounded.

Greater diameter, 17.00; lesser, 15.00; height, 10.50; mill. (11910.)
" " 18.00; " 15.00; " 12.00; " (12406.)

Animal: Blackish above and on head and eye-peduncles, yellowish-white on base and foot; foot long and narrow, 32 mill. long and 4 mill. wide (11910); eye-peduncles long and slender, tapering; heart situated on direct line drawn from the umbilicus to the upper termination of the peristome, beats eighty-eight per minute regular.

Jaw. Similar to that of *thyroides*, with ten ribs.

Radula formula: $\frac{3\,2}{1}+\frac{1\,1}{1}+\frac{1}{1}+\frac{1\,1}{1}+\frac{3\,2}{1}$ (43—1—43); similar to that of *P. thyroides*, but without side cusps on any of the teeth.

Genitalia: "The penis sac is the conspicuous feature of the system; it is longer than the oviduct and almost as stout, of about equal size throughout; it has the entrance of the vas deferens and the retractor muscle at its blunt apex. The genital bladder is small, lengthened oval, with a long, slender duct. The prostate is narrow, stout, prominent, cord-like. The vas deferens is large. The other organs present no peculiar features." (W. G. Binney.)

Distribution: Western Pennsylvania to Minnesota, south to Wyandotte, Kan., Jackson County, Alabama, and Sea Islands of Georgia. (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Found in moist woods under logs and débris of all kinds.

Remarks: Unless care is taken this species will be confounded with small forms of *thyroides*. Indeed, it has much the aspect of the form known as *bucculenta*. The aperture in *clausa* is always larger (in comparison to its size) and rounder than in *thyroides*, and the shell is always more globose and there is never a tooth on the parietal wall. The animal is very rapid in movement, is most inquisitive, and very readily crawls over the hand. It is a most uniform species, showing almost no variation. The specimens from Joliet are unusually large and fine. The species is not very common, except in the region around Joliet, and it is confined to the southern and western regions.

59. **Polygyra pennsylvanica** Green, pl. xxix, fig. 3.

Helix Pennsylvanica GREEN. Contr. to Macl. Lyc., Nos. 1, 8, 1827.

Shell: Obtusely conical, elevated, imperforate; surface sculpture as in *clausa;* color light yellowish, straw or dark horn; nuclear whorls smooth; periphery rounded; sutures well impressed; whorls five and one-half to six, rounded, convex, rather closely coiled; spire elevated, obtusely conical; aperture forming a triangle with rounded base, contracted behind the peristome, which is thickened, roundly reflected, white, with a small callosity near the umbilical region; the upper part of the peristome is more reflected than the rest, so that in a front view of the aperture this part presents a thin edge instead of a broad curved surface; terminations widely separated, connected by a very thin callus; umbilicus closed but the region indented; base flatly rounded.

Greater diameter, 18.50; lesser, 15.50; height, 12.00 mill. (12395.)
" " 17.00; " 15.00; " 13.00 " (12395.)

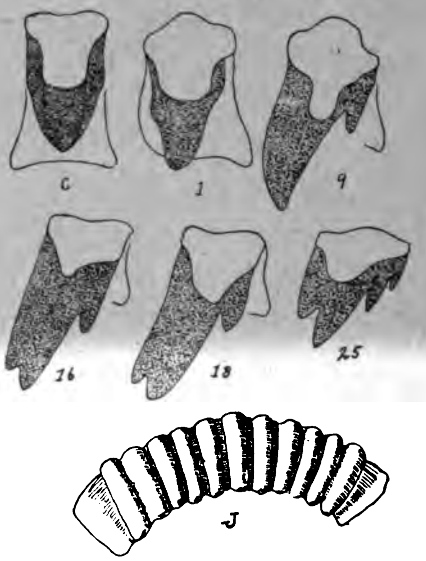

FIG. 24.

Radula of POLYGYRA PENNSYLVANICA Green. (Original.) c, central tooth; 1, first lateral; 9, second marginal; 16, 18, ninth and eleventh marginals; 25, eighteenth marginal; J, jaw.

Animal: With a long and narrow foot, 27.50 mill. long and 4 mill. wide; color blackish or lead color on head, neck and eye-peduncles lighter on base of foot; heart situated near junction of peristome with body-wall; pulsations regular, eighty-five per minute.

Jaw: Arched, ends squarely truncated; anterior surface armed with eleven wide, heavy ribs which denticulate the upper and lower margins. The jaw is of the same width throughout its length (Fig. 24, J).

Radula formula: $\frac{6}{4}+\frac{15}{2}+\frac{7}{1}+\frac{1}{1}+\frac{7}{1}+\frac{15}{2}+\frac{6}{4}$ (28—1—28); central tooth with a base of attachment a little longer than wide, the lower outer corners expanded; reflection long and wide, reaching almost to the lower edge of the base of attachment, with a large and well-developed central cusp and subobsolete side cusps; lateral teeth similar to central tooth, the outer lower angle of the base of attachment expanded, the side cusps represented by bulgings; marginal teeth variable, at first with a long and narrow spear-shaped inner cusp and a small outer cusp; the inner cusp soon becomes bifid (16–18), and finally the tooth becomes wider than long and with four sharp cusps; all of the teeth have well-developed cutting points (Fig. 24); there are about 120 rows of teeth. Binney gives 40–1–40 and Morse 39–1–39 teeth. The membranes examined were perfect.

Genitalia: "The penis sac is long and slender, with the vas deferens and retractor muscle entering its apex and its orifice entering the vagina near its base. The genital bladder is long, stout, cylindrical, with a median contraction; its duct is hardly distinct from it, with an entrance opposite that of the penis sac. The prostate is very large." (W. G. Binney.)

Distribution: Western Pennsylvania to Virginia, Illinois and Tennessee.

Geological distribution: Pleistocene; Loess.

Habitat: Same as that of *clausa.*

Remarks: This species is at once distinguished from *clausa*, the only species with which it is likely to be confounded, by its *imperforate* umbilicus, its triangular aperture, and its elevated, subconical spire. In confinement the animal is rather slow and careful in its movements. The shell is carried well balanced, a trifle back of the center of the animal, and lies almost flat. A variety occurs with a dark shell and purple lip. The species does not seem to be very common, and those found by the writer have been solitary in habit. It is confined to the southern and western regions.

60. **Polygyra multilineata** Say, pl. xxx, fig. 2.
Helix multilineatus SAY, Journ. Phil. Acad., Vol. II, p. 150, 1821.

Shell: Globosely depressed, rather fragile, imperforate; surface sculpture as in *profunda;* nuclear whorls smooth; color yellowish-horn or russet, with from fourteen to twenty reddish-brown bands of variable width; periphery rounded; sutures very deeply impressed; whorls five to six, rounded, regularly increasing in size, the last ventricose; spire depressed, convex; aperture broadly lunate, slightly contracted by the peristome; peristome thin, reflected, not much expanded; the upper portion near the body whorl is not expanded, but is a direct continuation of the last whorl, separated by a constriction; the peristome is sometimes grooved; terminations widely separated, connected by a thin callus; umbilicus closed by the reflection of the peristome near the columella, the region indented; base of shell flatly convex.

Greater diameter, 25.00; lesser, 21.00; height, 15.00 mill. (7714.)
" " 21.00; " 17.00; " 13.00 " (7715.)

Animal: Similar in form to *profunda;* color blackish all over, but the protuberances are lighter colored; the foot is very long and narrow, and the eye-peduncles long and tapering. Heart pulsations twenty-seven to thirty-four per minute; four specimens examined gave 27, 28, 31, 34 per minute. The animal is very slow and rather timid.

Jaw: As usual, slightly arcuated, with ten ribs of good size which denticulate both margins; the ends are almost square. The jaw resembles that of *Polygyra pennsylvanica.*

Radula formula: $\frac{25}{2+3}+\frac{17}{2}+\frac{1}{3}+\frac{17}{2}+\frac{25}{2+3}$ (42—1—42); the teeth resemble those of *Polygyra profunda*, excepting that all after the twenty-fourth tooth and all beyond have the inner cutting point bifid. Some membranes have the formula $\frac{24}{2+3}+\frac{16}{2}+\frac{1}{3}+\frac{16}{2}+\frac{24}{2+3}$ (40—1—40), there being but sixteen perfect laterals. One apparently perfect membrane had 130 rows of teeth.

Genitalia: "Penis sac long, stout, with a very highly developed prepuce on the greater part of its course, then tapering to its summit, where it receives the vas deferens and retractor muscle; genital bladder long, subcylindrical, its duct but slightly smaller, short, swollen at its entrance into the vagina; oviduct greatly convoluted." (W. G. Binney.)

Distribution: Western New York to Minnesota and Iowa, south to Kentucky, Kansas and Virginia.

Geological distribution: Pleistocene; Loess.

Habitat: Marshy woodlands and meadows in the vicinity of streams.

Remarks: This species may usually be distinguished by its imperforate shell and numerous spiral color-bands. The young are difficult to distinguish from *profunda;* the bands, however, are more numerous in the present species than in *profunda* (see the latter species for additional remarks). This is not a common mollusk and is limited in distribution to the southern and western regions. It frequents marshy woodlands and loves to be where there is plenty of water, moisture seeming to be a necessity to its existence. It is one of the most beautiful of the larger Helices. At Joliet it ranges in color from almost pure white, without bands, through various shades of horn to dark purplish or blackish, with bands; the latter exhibit every variety of width and number.

60a. **Polygyra multilineata alba** Witter.

Helix multilineata var. *alba* WITTER, Journ. of Conch., Vol. I, p. 384, 1878.

60b. **Polygyra multilineata rubra** Witter.

Helix multilineata var. *rubra*, WITTER, l. c., p. 384, 1878.

The varieties *alba* and *rubra* are found somewhat sparingly at Joliet. The first has a perfectly plain horn-colored shell and the latter a plain reddish or chestnut-colored shell, which is very beautiful.

SECTION STENOTREMA Rafinesque.

Shell: "Small, *compact*, imperforate or umbilicate; subglobose, globose-depressed or lens-shaped the periphery varying from rounded to acutely keeled; *surface dull, smooth, generally hairy.* Whorls 5-6, *closely revolving*, the last suddenly deflexed in front. *Aperture basal, narrow, obstructed by an oblique blade-like parietal tooth parallel to the reflexed basal lip*, the latter often notched in the middle. Last whorl generally having in its last fourth a short transverse partition on the axis." "Genital system having the penis notably longer than the receptaculum semmis and its duct, the latter quite short." (Pilsbry, l. c., p. 77.)

61. **Polygyra hirsuta** Say, pl. xxix, fig. 9.

Helix hirsuta SAY, Journ. Phil. Acad., Vol. I, p. 17, 1817.

Helix ? porcina SAY, Long's Exped., Vol. II, p. 257, pl. xv, fig. 2, 1824. (Young.)

Helix fraterna WOOD, Index, Suppl., p. 21, pl. viii, fig. 16, 1828.

Helix sinuata GMELIN (teste Pfeiffer).

Helix isognomostomos GMELIN (teste Pfeiffer).

Polygyra hirsuta altispira PILSBRY, The Nautilus, Vol. VII, p. 141, 1894. (Variety.)

Polygyra hirsuta pilula PILSBRY, Proc. Phil. Acad., p. 132, 1900. (Variety.)

Polygyra hirsuta uncifera PILSBRY, l. c., p. 453, 1900. (Variety.)

Shell: Subglobose, rather solid, imperforate; surface covered with numerous short, stiff hairs, beneath which may be seen fine growth lines; nuclear whorl without hairs; color reddish-brown or chestnut; periphery subangulated; sutures very deeply impressed; whorls five, rounded, slowly and regularly increasing, the last deflected near the aperture and constricted behind the peristome; spire a little elevated, convex; aperture nearly closed by the thickened peristome and parietal tooth; parietal tooth long and narrow, elevated, extending from the center of the base of the shell into the aperture near the upper part; peristome narrow, thickened, reflected against the whorl with a small, well-marked notch near the center of the base of the aperture; umbilicus covered and the region indented; base of shell convex; within the base of the shell, situated beyond the line of sight, is a transverse tubercle, which starts from the apex; this cannot be seen without breaking the whorls.

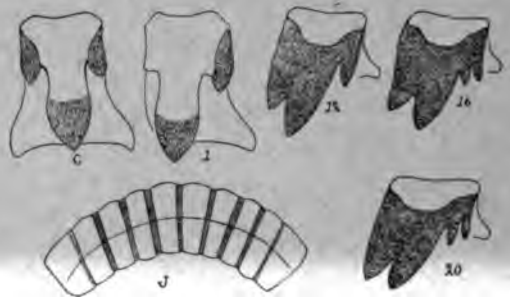

FIG. 25.

Jaw and radula of POLYGYRA HIRSUTA Say. (Original.) c, central tooth; 1, first lateral; 12, intermediate tooth; 16, 20, marginal teeth; J, jaw.

Greater diameter, 7.75; lesser, 7.00; height, 5.00 mill. (8451.)
" " 8.30; " 7.75; " 5.00 " (10438.)
" " 9.00; " 8.00; " 5.00 " (12399.)

Animal: With a long, narrow foot, truncated before, pointed behind; head distinct, blackish or slate color, as well as the tentacles and eye-peduncles; tentacles short, blunt; eye-peduncles long, thick, cylindrical, the eyes on enlargements at their tips; the foot and a part of the body is semi-transparent; foot 13 mill. long and 2 mill. wide. Heart situated to the left of the center of the parietal tooth, pulsations regular, eighty per minute.

Jaw: Similar to *Polygyra monodon*, but with eight stout ribs (Fig. 25, J).

Radula formula: $\frac{10}{4}+\frac{5}{3}+\frac{10}{2}+\frac{1}{3}+\frac{10}{2}+\frac{5}{3}+\frac{10}{4}(25-1-25)$; central tooth with a base of attachment a trifle longer than wide, the outer lower corners expanded; reflection tricuspid, the central cusp very long, reaching to the margin of the base of attachment, side cusps very small; lateral teeth similar to central tooth, bicuspid, the inner cusp very long, the outer very short. The marginal teeth begin at the eleventh tooth and may be known by the splitting of the inner cusp; from the sixteenth tooth the outer cusp is split and the whole tooth becomes wider (Fig. 25).

Genitalia: "Penis sac long, cylindrical, blunt above, where it receives retractor muscle and vas deferens; genital bladder narrow, elongate-ovate, on a short, narrow duct; the convolution in the epididymis commences near the testicle." (W. G. Binney.)

Distribution: Canada, Eastern and Interior regions of the United States, Yaqui River, Guaymas, Mexico.

Geological distribution: Pleistocene; Loess.

Habitat: Found in damp places under fallen logs, in rotten wood, under stones, etc.

Remarks: A species at once distinguished by its contracted aperture, notched peristome and heavy parietal tooth. It is one of our most abundant Helices, and in some localities is the predominating species. In its movements *hirsuta* resembles *P. monodon.* At Bowmanville it may be collected very abundantly in the woods just west of Lincoln Avenue. The species is widely distributed, being found in all the regions of the area.

62. **Polygyra monodon** Rackett, pl. xxx, fig. 4.

Helix monodon RACKETT, Linn. Trans., Vol. XIII, p. 42, pl. v, fig. 2, 1822.

Helix convexa CHEMNITZ, part (excl. syn. et tab. LXVI, figs. 24, 27), pl. x, figs. 17, 18.

Helix leaii WARD MSS. teste Binney.

Helix cincta LEWIS, Proc. Phil. Acad., p. 162, 1874. (Variety.)

Polygyra monodon aliciæ PILSBRY, The Nautilus, Vol. XI, p. 105, 1898. (Variety.)

Polygyra monodon albida WALKER, Terr. Moll. Mich., p. 15, 1899. (Variety.)

Polygyra monodon friersoni PILSBRY, The Nautilus, Vol. XIII, p. 36, 1899. (Variety.)

Polygyra monodon imperforata PILSBRY, Proc. Phil. Acad., p. 455, 1900. (Variety.)

Shell: Subglobose, solid, umbilicate or imperforate; surface covered with very fine, oblique growth lines which are so minute as to be scarcely visible even when viewed with a powerful glass; the surface is also set with short hairs scattered over the whorls; nuclear whorls smooth; periphery rounded; sutures well impressed; color yellowish to reddish horn; whorls five to five and one-half closely coiled, flatly rounded, the last gibbous on the last half and constricted behind the peristome; spire somewhat elevated in some specimens, but flat in others, convex; aperture narrowly lunate, no teeth or notches on the peristome; parietal wall with a long, narrow, more or less elevated tooth, which begins near the center of the parietal wall and extends generally to the umbilical region in a line parallel with the basal reflection of the peristome; peristome white, thick, reflected, umbilicus widely open, or wholly imperforate; the region strongly depressed; base of shell rounded, with a transverse internal tubercle.

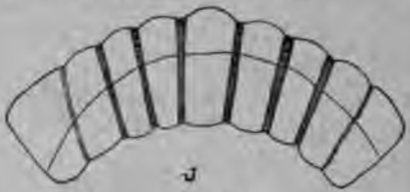

FIG. 26.

Jaw of POLYGYRA MONODON Rackett. (Original.)

Greater diameter, 8.50; lesser, 8.00; height, 4.50 mill. (8454.)
" " 9.00; " 8.25; " 5.25 " (8453.)
" " 8.50; " 7.75; " 5.00 " (9128.)

Animal: With a long, narrow foot truncated before, pointed behind; head distinct; tentacles short, cylindrical, thick; eye-peduncles long, thick, not much tapering, the black eyes situated on large swellings at the tips; color brownish-yellow, almost black on head, neck, tentacles, and eye-peduncles, lighter on the foot; respiratory orifice not large. Heart situated between the tooth on the parietal wall and the junction of the upper part of the peristome with the body-wall. Pulsations regular, seventy-one to seventy-six per minute. Length of foot 11, width 2 mill.

Jaw: Arched, ends blunt, rounded; anterior surface with seven stout ribs which denticulate both margins (Fig. 26).

Radula formula: $\frac{3}{5}+\frac{10}{3}+\frac{11}{2}+\frac{1}{3}+\frac{11}{2}+\frac{10}{3}+\frac{3}{5}$ (24—1—24);

central tooth as in var. *fraterna;* lateral teeth similar to those in var. *fraterna*, the inner cusp becoming elongated toward the tenth tooth; marginal teeth similar to those of var. *fraterna*, but the last three teeth with three outer cusps and two inner cusps, the second from the left being much the larger. There are about 100 rows of teeth.

Genitalia: See var. *fraterna.*

Distribution: Ohio and Michigan to Minnesota, south to Nashville, Tenn., and Neosho County, Kan. (Pilsbry.)

Geological distribution: Pleistocene of the Mississippi Valley; Loess.

Habitat: Found under dead logs and chips in most localities. Associated with *Gastrodonta arborea, Vitrea electrina, Pyramidula striatella*, etc.

Remarks: This species is distinguished from all others found in the area by its white, entire peristome, large parietal tooth and its (generally) open umbilicus. In a recent paper (Proc. Phil. Acad., 1900, p. 454), Mr. Pilsbry has rearranged the nomenclature of this species, making the shell formerly known as "*leaii* Ward" the typical *Monodon*, the forms heretofore known under that name becoming variety *fraterna*. *Monodon* is one of our most common species and is generally found in little colonies of from six to a dozen or fifteen individuals. It has been collected in the southern and western regions only, but will no doubt be found in the northern.

62 a. Polygyra monodon fraterna Say, pl. xxx, fig. 3.

Helix fraterna SAY, Long's Exped., Vol. II, p. 257, pl. xv, fig. 3, 1824

Shell: Differing from *Monodon* in being larger, more hirsute, in having the umbilicus frequently partly closed or wholly imperforate and in being less convex than the type.

Greater diameter, 11.50; lesser, 10.50; height, 7.50 mill. (9964.)
" " 11.00; " 10.00; " 7.00 " (9964.)
" " 10.00; " 9.00; " 7.00 " (8449.)

Animal: With a long, narrow and cylindrical foot, truncated before and pointed behind; color yellowish-white on foot and sides of body, darker on head, tentacles, eye-peduncles and top of head; eye-peduncles very long, cylindrical; tentacles short, blunt; foot 22 mill. long, 5.50 mill. wide. Heart pulsations regular, one hundred per minute. The pustules on the body stand out very prominently.

Jaw: As in *Monodon* with seven ribs.

Radula formula: $\frac{14}{3}+\frac{7}{2}+\frac{10}{2}+\frac{1}{3}+\frac{10}{2}+\frac{7}{2}+\frac{14}{3}$ (31 – 1 – 31);

central tooth with a base of attachment longer than wide, the base excavated and the lower outer corners much expanded; reflection tricuspid, the central cusp long and wide, very nearly reaching the lower margin of the base of attachment, side cusps very short; lateral teeth similar to the central tooth, but bicuspid, the inner cusp much the larger; marginals variable, at first similar to laterals, but soon the inner cusp (twenty) becomes bifid, changes into a perfect cusp (twenty-three trifid), and finally the reflection becomes very narrow and with three cusps, of which the central one is the largest (Fig. 27). There are about 100 rows of teeth. Binney gives 21-1-21 and Morse 28-1-28 teeth.

Genitalia: "The characteristic feature of the genitalia is the penis sac. It is unproportionally long, club-shaped, and greatly enlarged above, where it receives both vas deferens and retractor muscle. The genital bladder is small, elongate-oval, on a short, delicate duct. The epididymis is convoluted in its whole length." (W. G. Binney.)

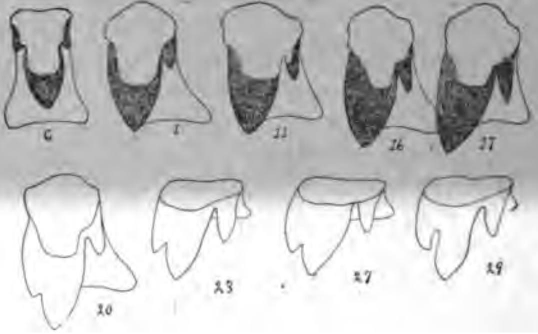

FIG. 27.

Radula of POLYGYRA MONODON FRATERNA Say. (Original.) c, central tooth; 11, first marginal tooth; 16, 17, 20, intermediate marginal teeth; 23, 27, 29, outer marginal teeth.

Distribution: Canada to Minnesota, south to North Carolina and San Antonio, Tex. (Pilsbry.)

Geological distribution: Pleistocene of the Mississippi Valley; Loess.

Habitat: Found sparingly under pieces of bark, chips, logs, etc., in open patches of woodland or in meadows. The variety in this area does not congregate together but is found either singly or with one or two companions. Associated sometimes with *P. thyroides* and *Pyramidula alternata.*

Remarks: The variety (which was formerly known as typical *monodon*) may be distinguished from the typical form by its larger shell, more hirsute surface and generally less widely open umbilicus. It is very abundant in the Big Woods west of Evanston, where it attains a large size and great perfection. It is rather widely distributed but has not yet been found in the southern region. The forms having an imperforate umbilicus are rare and have only been found in the western region.

Superfamily Agnatha.

Mouth without jaw; radula with numerous sharp, aculeate or fang-shaped teeth, the center tooth wanting or rudimentary; neck generally elongated and furrowed along the back; cerebral ganglia separated, connected by a rather long commissure.

FAMILY TESTACELLIDÆ.

"Animal slug-like, bearing a small ear-shaped shell near the posterior extremity of the body. No jaw. Lingual teeth long and narrow, sharp-pointed, in oblique series."*

Genus **TESTACELLA** Cuvier.

"*Animal:* Limaciform, subcylindrical, tapering anteriorly; tentacles simple; mantle small, posterior, quite near the tail, covered with a small external shell; no longitudinal furrows above the margin of the foot, and no caudal mucus pore; no distinct locomotive disk; external respiratory and anal orifice at the posterior right edge of the mantle under the peristome of the shell; combined generative orifice behind and below the right eye-peduncle."

"*Shell:* External, rudimentary, imperforate, ear-shaped, with a subspiral, posterior nucleus." (Tryon.)

Distribution: Europe, Canary Islands, United States (introduced).

63. Testacella haliotoidea Fer., pl. xxxi, fig. 24.

Testacella haliotoidea FER., Hist. Nat. Des. Moll., pl. viii, Figs. 5-9, 1820.

Shell: Small, ear-shaped, partly spiral; apex small, subspiral, posterior; columella broad, flat, excavated; surface roughened by growth lines; interior white and pearly, exterio chestnut brown.

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*Tryon, S. and S. Conch., Vol. 3, p. 11.

Length, 7.00; breadth, 4.50; aperture, length, 6.00; breadth, 3.50 mill. (16652.)

Animal: Limaciform, broad and rounded at the posterior end, tapering toward the anterior end; eye-peduncles cylindrical, rather long, the eyes at their tips; tentacles simple, short; mantle placed near the posterior end, very small; surface of body roughened by small folds and furrows; no pedal grooves present; color brownish on back and sides of body, light yellowish on base and sides of foot.

Jaw: Wanting.

Radula: 20-0-20; central tooth rudimentary or wanting; lateral teeth long and narrow, with a barbed point and a swelling on the center of the posterior side. There are about 50 rows of teeth (Fig. 28).

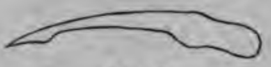

FIG. 28.

Lateral tooth of TESTACELLA HALIOTOIDEA Fér. (Original.)

Distribution: Southern Europe; Great Britain and America (introduced); Canary Islands.

Geological distribution: Unknown.

Habitat: So far as known this species has only been found in this country in greenhouses, where it has been introduced on plants.

Remarks: *Testacella* is one of the few truly predaceous pulmonates. It is nocturnal in habit and feeds upon worms, other mollusks and even upon its own species. It will pursue an earthworm through its many subterranean burrows or galleries with a persistency that recalls the ferocity of the tiger. During the day the animal buries itself deep in the ground, and in winter it forms a cyst or cocoon by the exudation of mucus. It is common in Southern Europe and has been introduced into Great Britain, where it has multiplied very rapidly. At the present time it is known in this country in the greenhouses at Nova Scotia, at Roxborough, Philadelphia, Penn., and one specimen has been found in the greenhouses at Lincoln Park, Chicago. It will probably be found in the greenhouses of other cities.

Superfamily Agnathomorpha.

Mouth provided with jaw; radula with aculeate teeth; mouth frequently developing finger-like appendages; cerebral ganglia concentrated, in close contact.

FAMILY CIRCINARIIDÆ.

"Foot-edges with no trace of pedal grooves; no tail gland; sole undivided. Side teeth unicuspid, thorn shaped, with narrow basal-plates. Shell with simple lip and without opaque markings."*

GENUS **CIRCINARIA** (Beck, 1837). Pilsbry.

Macrocyclis Beck, of Authors.
Selenites Fischer, 1878 (non Hope). *Haplotrema* Anc.

"*Shell:* Thin, widely umbilicated, depressed, striate or wrinkled, color uniform; whorls 4½-5, the last broad, depressed, moderately deflexed in front; aperture obliquely ovate; peristome somewhat thickened or expanded, the margins approximating, the basal shortly reflexed."

"*Animal:* Heliciform; mantle posterior, covered with a shell; eye-peduncles long, slender; foot narrow, twice as long as the diameter of the shell, tail pointed, scarcely reaching behind the shell; respiratory and anal orifices on the right of the mantle, under the peristome of the shell; generative orifice behind the right eye-peduncle; no distinct locomotive disk or caudal mucus pore. Carnivorous."

"*Jaw:* Crescentic, ends sharply pointed, anterior surface striated; cutting margin smooth, with a median projection."**

Radula: With numerous rows of teeth arranged *en chevron.* For detail of the radula see *concavus.*

"*Genitalia:* The epididymis is extremely long and very large, forming the peculiar feature of the system. The genital bladder is oval, with a long duct, which is very much broader at the end nearer the vagina. The penis sac is long, gradually tapering at its apex, where it receives the vas deferens. Upon the side of the vagina, about the middle of its length, is a wart-like protuberance, which may be a dart-sac or a vaginal prostate."**

Distribution: North America.

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*Pilsbry, Guide to Helices, p. XXVIII.

**W. G. Binney, Man. Amer. Land Shells, pp. 79 and 83.

64. **Circinaria concava** Say, pl. xxviii, fig. 4.
Helix concava SAY, Journ. Phil. Acad., Vol. II, p. 159, 1821.
Helix planorboides FERUSSAC, Hist. Nat. Des. Moll., pl. lxxxii, fig. 4.
Helix dissidens DESHAYES, in FERUSSAC, Hist. Nat. Des. Moll., Vol. I, p. 97, pl. lxxxiv, figs. 1, 2.

Shell: Depressed, rounded, almost flat on the upper surface; color light yellowish-horn, with a tinge of greenish; surface shining, covered with numerous crowded, raised lines of growth; whorls five, rounded below, flat above, the outer whorl somewhat spreading as it approaches the aperture; spire flat or only slightly convex; sutures very deeply excavated as they approach the aperture; aperture rounded-oblique, flattened above by a deflection of the peristome; the aperture is frequently tinged with brownish; peristome flattened and deflected above its junction with the last whorl, the portion near the columella subreflected; columella with a rather thin callus, which connects the two extremes of the peristome; umbilicus wide, deep, spreading, showing all the volutions to the apex; base of shell rounded.

Greater diameter, 15.00; lesser, 12.50; height, 6.50; umbilicus, 5.00 mill. (10094.)

Greater diameter, 14.00; lesser, 12.00; height, 6.50; umbilicus, 4.50 mill. (7766.)

Animal: (Fig. 29.) With a narrow body; anterior portion much in advance of shell; color blackish, mottled with light horn; eye-peduncles long, cylindrical, bluish, eyes at tip, on rounded protuberances; tentacles comparatively long and slender, cylindrical; foot obtusely rounded behind, blunt before; creeping disk long and rather broad; head prominent; respiratory orifice on right side just beneath a point where the peristome meets the body of the last whorl; contractions of foot strongly marked when viewed through a glass; base of animal dirty white; collar reddish-orange. Length of foot 14.25 mill., with 4.00 mill.

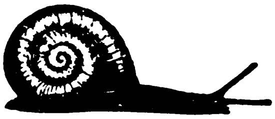

FIG. 29.
Animal of CIRCINARIA CONCAVA Say. (After Binney.)

The heart is situated 5 mill. from the edge of the aperture, and is very plainly seen through the transparent shell, especially if it be moistened. The pulsations are very regular, but vary in number, being more numerous when the animal is extended, as during locomotion, and few when the animal is contracted. From twenty experiments the following data are taken, ranging from the smallest to the highest number: 50, 56, 72, 75, 78, 82. Temperature greatly affects the heart, cold causing it to apparently cease, while heat accelerates its action.

Jaw: Crescent-shaped, with bluntly rounded ends; concave margin smooth, supporting a median projection; striated on its anterior face (Fig. 30, B).

Radula formula: $\frac{19}{1}+\frac{6}{3}+\frac{1}{3}+\frac{6}{3}+\frac{19}{1}$ (25–1–25) in 32 rows; central tooth small, triangular, with a rather large base of attachment which is much expanded on the outer lower corners; the apex of the triangle is truncated and incurved, the cutting point long and well-developed, with subobsolete side cusps; lateral teeth with as ole-shaped base of attachment, the lower lateral expansions angular; cusps long and slender, cutting points long and narrow, with subobsolete side points; marginals (all after the first six) long and aculeate, base of attachment sole-like with long and narrow cusps and cutting points (Fig. 30, A). Binney gives 20–1–20 and 23–1–23 teeth.

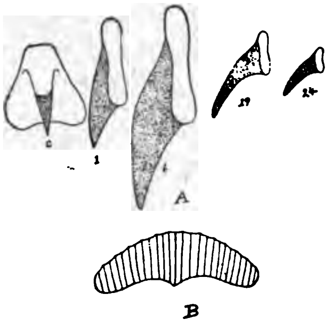

FIG. 30.

A, teeth, and B, jaw of CIRCINARIA CONCAVA Say. (Original.) c, central tooth; 1, first lateral; 6, sixth lateral. 19, thirteenth marginal; 24, nineteenth marginal.

Distribution: Maine west to Minnesota and Iowa, Canada south to Georgia and Mississippi.

Geological distribution: Pleistocene; Loess.

Habitat: Found buried in the soil under dead and decaying logs, fallen underbrush and rubbish. It prefers a forest that is cool and damp, and affording shade from the sun's rays. The banks of rivers are good localities.

Remarks: This species is so distinct that it cannot be confounded with any other. It is rather shy in captivity and quickly retracts within its shell when disturbed. It is not a common species with us, and has thus far been found in but few localities. Those in this area do not seem to congregate together in large numbers, as do many of our snails, but are found either singly or only two or three together. It is a perfect cannibal, and will very quickly "clean out" a snailery of half a dozen or more common Helices. Thrusting out its long body it crawls into the shells of its victims, and no matter how far the latter may contract within their shells, it is of no avail against the carnivorous appetite of *Circinaria*. It may well be termed the tiger of the Molluscan kingdom. It preys upon its own as well as upon other species, thus being in truth a cannibal. Thus far it has only been found in the northern and western regions. *Concava* has been found at Bowmanville under "starting" bark at a height of four feet from the ground. The animal is very nervous in progression, constantly extending and retracting its eye-peduncles, the shell swaying from side to side with a wabbly motion.

On May 18, 1897, two individuals were seen in copulation; the coitus lasting over ten hours (from 8 o'clock a. m. until 6 o'clock p. m.); the eye-peduncles were almost drawn into the head, and the foot was contracted to form a long oval; the heart beat very slowly, nineteen pulsations being counted per minute (about eighty being normal) and the beats were very long.

Superfamily Aulacopoda.

"Animal with well-developed pedal grooves. Shell sharp-lipped." (Pilsbry.)

FAMILY ZONITIDÆ.

"Marginal teeth with narrow, elongated basal-plates, and either unicuspid and thorn-shaped by suppression of side cusps, or bicuspid by elevation of outer on middle cusp. Tail gland often present, and sole frequently tripartite."[*]

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[*] Pilsbry, Guide to Helices, p. XXVIII.

Subfamily Zonitinæ.

GENUS OMPHALINA Rafinesque.

Omphalina Rafinesque, Enum., etc., p. 3, 1831.
Mesomphix (in part) BECK, Index Moll., p. 7, 1838.

"Shell rather large and solid but thin, umbilicated, smooth below, lacking teeth or folds within; the lip simple and sharp."

"Foot double grooved above its margin, the grooves meeting above the tail in a mucus pore; sole tripartite; dorsal surface from head to mantle entirely lacking longitudinal grooves."

"Genital system lacking dart sac and other accessory gland. In *O. fuliginosa* the penis (P.), is a rather short stout sac, with the retractor muscle (rp.) inserted at its apex, and attached distally to the floor of the lung. Internally the distal half of the cavity of the penis is densely, finely and rather sharply granulated; the opening of the vas deferens is near the apex of the cavity, and is not provided with a papilla. The lower portion of the vas deferens (vd.) is enormously swollen; and for a short distance from its insertion it is firmly bound to the penis itself."

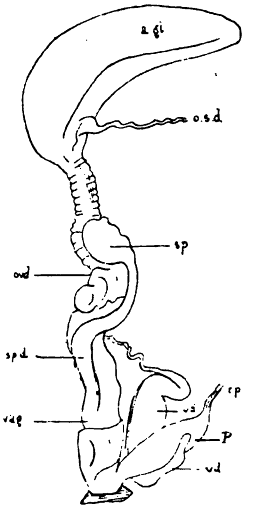

FIG. 31.

Genitalia of OMPHALINA FULIGINOSA Griffith. (After Pilsbry, Proc. Phil. Acad. Sci., 1894, pl. i, Fig. 5.) P, penis; agl, albumen gland; ovd, oviduct; rp, retractor muscle of penis; sp, spermatheca; spd, duct of same; vag, vagina; vd, vas deferens.

"The vagina (vag.) is curiously swollen near the base. The spermatheca (sp.) is large, subglobular, and together with its rather long duct, is bound firmly to the oviduct. The albumen gland (a. gl.) is uncommonly large"* (Fig. 31).

Jaw and *Radula:* See *O. fuliginosa.*

Distribution: North America.

65 **Omphalina fuliginosa** Griffith, pl. xxviii, fig. 15.

Helix fuliginosa GRIFFITH in Letters; BINNEY, Terr. Moll., Vol. II, p. 222, pl. xxxi, 1851.

Helix capillacea PFEIFFER, Symbolæ, Vol. II, p. 24, not FER., teste PFR.

Omphalina cuprea RAFINESQUE, Enum., etc., p. 3.

Omphalina fuliginosa polita Pilsbry, The Nautilus, Vol. XI, p. 129; Vol. XII, p. 86, 1898. (Variety.)

Shell: Depressed above, globose below, thin, umbilicated; surface shining, covered with very fine lines of growth, which seem to disappear on the apical whorls; color greenish-horn or chestnut; periphery rounded; sutures little impressed, but well marked; whorls six and one-half, rounded, rapidly increasing, the last very large and expanding; spire almost flat; aperture large, oblique, lunately ovate, frequently showing iridescence within; peristome simple, very thin and brittle, a thin testaceous deposit within; columella slightly reflected, terminations of the aperture approaching, often connected by a light, testaceous deposit; umbilicus narrow, deep; base of shell globose.

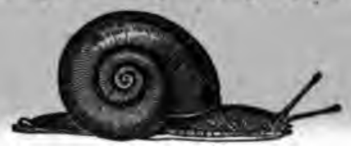

FIG. 32.
Animal of OMPHALINA FULIGINOSA Griffith. (After Binney.)

Greater diameter, 16.00; lesser, 14.00; height, 10.50; umbilicus diameter, 175 mill. (7732.)

Animal: (Fig. 32). With a long, narrow foot, broad before and obtusely pointed behind; color black; head, neck and eye-peduncles very dark; eye-peduncles of medium length, widely separated, tapering, with the eyes placed at their extremity; under part of foot whitish or grayish, the locomotive portion separated from the upper part by several scarcely distinguishable furrows; pedal grooves extending along the sides of the foot from the head to the posterior extremity, the two ends meeting above the tail where a rounded and prominent mucus gland is formed. This gland has the power of closing and expanding.

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*Pilsbry, Proc. Phil. Acad., 1894, p. 14.

Jaw: "Very arcuate, of almost uniform breadth, ends blunt; anterior surface with transverse striæ; concave margin simple, with a well developed, blunt, median projection." (W. G. Binney.)

Radula: "Lingual membrane very broad, composed of 87 rows of 129 (64-1-64) long, slender teeth each; centrals tricuspid; laterals 4, bicuspid, in a straight, transverse row; marginals aculeate, in a somewhat crescentic row. Another membrane had 57-1-57 teeth." (W. G. Binney.)

Genitalia: See under *Omphalina.*

Distribution: Southern Canada south to Florida, west to Michigan and Arkansas.

Geological distribution: Pleistocene; Loess.

Habitat: In moist, somewhat open woodlands.

Remarks: A species easily distinguished by its large size and glossy surface. The only locality from which authentic specimens have been obtained is near Maywood, in 1892. During the last three years the writer has carefully searched all about that region but without securing a single specimen. It is, therefore, a doubtful species for this region.

GENUS **VITREA** Fitzinger.

Vitrea FITZINGER, Syst. Verzeich, p. 99, 1833.
Hyalinia AGASSIZ, in CHARPENTIER, Nouv. Mem. Soc. Helv., Vol. I, p. 13, 1837.
Hyalina of BINNEY, TRYON, and other authors.
Polita HELD, Isis, p. 916, 1837.
Glyphyalinia MARTENS, Biol. Cent. Amer. Moll., p. 117, 1892.

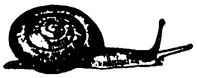

FIG. 33.

Animal of VITREA CELLARIA Müller. (After Binney.)

Shell: Small, thin, glassy, shining, heliciform; spire generally depressed; aperture rounded or lunate; peristome very thin, acute.

Animal: With no accessory organs upon the genital system; dart sac not present; other characters as in *Omphalina* (Fig. 33).

Distribution: Europe and America.

KEY TO SPECIES OF VITREA.

A. Shell large, exceeding 10 mill. in diameter; widely umbilicated; aperture much expanded................*draparnaldi*

B. Shell small, less than 10 mill. in diameter.

  a. Shell umbilicated..*hammonis*

  b. Shell imperforate, but indented about the umbilical region..*indentata*

66. Vitrea draparnaldi Beck, pl. xxviii, fig. 5.

Helix draparnaldi BECK, Index Moll., p. 6, 1837.

Shell: Of good size, depressed, thin, but solid when adult, pellucid, umbilicated; surface smooth, polished, shining, marked by numerous very fine, oblique lines of growth; color greenish-horn, sometimes lighter; periphery rounded; sutures very deeply impressed; whorls five to five and one-half, rounded, convex very regularly increasing, the upper surface flatly convex; aperture a little oblique, transverse, not dilated, the transverse diameter much longer than the height; peristome simple, thickened, terminations widely separated; umbilicus round, broad, deep, exhibiting a few of the volutions; base of shell rounded, thickened within by a deposit of bluish-white testaceous matter.

Greater diam., 15.50; lesser, 13.00; height, 8.00; umbilicus diam., 2.75 mill. (10108.)

Greater diam., 7.00; lesser, 5.75; height, 3.00; umbilicus diam., 1.50 mill. (10148.)

Animal: With a long, narrow foot, long and slender eye-peduncles, and short tentacles; color slaty-blue, indigo-blue or blackish above, darker on head, eye-peduncles and neck; collar greenish; animal much lighter beneath; a locomotive disk present and pedal grooves meeting above the tail, much as described in *V. fuliginosa.* Heart situated as in *Zonitoides arboreus,* pulsations regular, numbering as follows: 46, 51, 52, 57, 61, 71, 84. In some specimens the beats were quite irregular and may be represented by the following diagram (Fig 34) in which the dash represents the interval between each heart-beat:

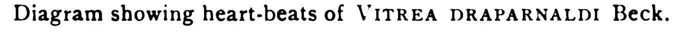

FIG. 34.

Diagram showing heart-beats of VITREA DRAPARNALDI Beck.

The smallest number of beats is when the animal is contracted, and the largest when extended. Length of foot 25.50 mill., width 3.00 when fully extended.

Jaw: Arched, ends bluntly rounded; dorsal margin rounded, ventral margin with a sharp median projection; anterior surface striated (Fig. 35, J).

Radula formula: $\frac{11}{1}+\frac{1}{2}+\frac{2}{3}+\frac{1}{3}+\frac{2}{3}+\frac{1}{2}+\frac{11}{1}$ (14—1—14); central tooth very long and narrow, lower outer corners of base of attachment expanded and the lower border with a central projection; reflected portion tricuspid, the central cusp rather long and narrow, the side cusps almost obsolete, the central cusp only having a cutting point; laterals similar to central but wider, tricuspid, the central cusp short and wide, the inner cusp the same and the outer cusp, small, placed higher up on the reflection, only the central and inner cusp having cutting points; the outer cusp of the second lateral is placed higher up than on the first lateral, and on the third lateral has disappeared; marginal teeth of the pure aculeate form (Fig. 35). There are about 40 rows of teeth.

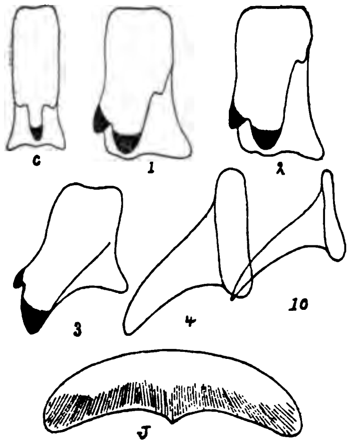

FIG. 35.

Teeth and jaw of VITREA DRAPARNALDI Beck. (Original.) c, central tooth; 2, second lateral; 3, third lateral; 4, first marginal; 10, seventh marginal; J, jaw.

Distribution: Europe, America and Australia (introduced). Found in the United States in the greenhouses at Seattle, Washington, Oakland and San Francisco, Cal., Chicago, Ill.

Geological distribution: Pleistocene.

Habitat: In greenhouses on plants, but more generally under or about old boards in damp places.

Remarks: This species is somewhat new to the snail fauna of the United States, and has been found only in California, Washington and Chicago. It is the largest species of the genus found in the United States, and may be known by its flat form, very transverse aperture, deep umbilicus and indented umbilical region. It has been found somewhat plentifully in the greenhouses at Lincoln Park, Chicago, but is particularly large and fine in the greenhouses at Washington Park, where it is found beneath old boards under the flower pot shelves. Specimens have been found here measuring over half an inch in diameter. It has not been found outside of the greenhouses.*

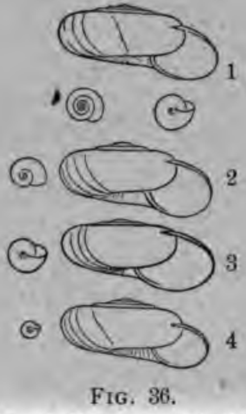

FIG. 36.

Comparative figures of VITREA and ZONITOIDES. (After Morse, Amer. Nat., Vol. 1, Nos. 8 and 10.) Enlarged. 1, ZONITOIDES ARBOREUS Say; 2, VITREA HAMMONIS Ström; 3, VITREA INDENTATA Say; 4, ZONITOIDES MINUSCULUS Binney.

67. Vitrea Hammonis Ström, pl. xxviii, fig. 10.

Helix hammonis STRÖM, Act. Nedross., Vol. III, p. 435, pl. vi., fig. 16, 1795.
Helix radiatula ALDER, Cat. North and Durh., p. 12, No. 50, 1848.
Helix viridula MENKE, Syn. Méth., ed. 2, p. 127.
Helix striatula GRAY, non Linné, nec Müller; undescribed.
Helix nitidosa FERUSSAC; undescribed.
Helix electrina GOULD, Inv. Mass., p. 183, fig. 111, 1841.
Helix pura PFEIFFER, Binney, non Alder.
Helix viridula PFEIFFER, *ex parte*, 1848, non 1881; Binney apud Pfeiffer, non Menke.
Helix hammonis WESTERLUND, Mörch, Pfeiffer, 1881.†
Hyalina pellucida LEHNERT, Science Record, June, 1884, p. 141.

Shell: Small, depressed, thin, umbilicated; surface shining, the lines of growth well marked, impressed, more or less equi-

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*Mr. W. W. Calkins has reported the finding of *Zonites alliarius* Müller in Chicago greenhouses, but thus far the record has not been substantiated. All of the specimens have been *draparnaldi*.

†From Dall, Proc. U. S. Nat. Mus., 1885, p. 269.

distant; color brownish-horn, transparent; periphery rounded; sutures well impressed; whorls four, rapidly enlarging, the last half of the last whorl very rapidly enlarging as it approaches the aperture; spire flat or a trifle convex; aperture large, transversely rounded, somewhat expanded; peristome simple, with thickened edge; umbilicus small, round, deep, showing several of the volutions, the umbilical region strongly concave; base of shell convex (See Fig. 36).

Greater diam., 4.25; lesser, 3.75; ht., 2.50; umbilicus diam., 0.50 mill. (10103.)
" " 4.00; " 3.50; " 2.25; " " 0.50 " (10104.)
" " 3.75; " 3.00; " 2.00; " " 0.50 " (10652.)
" " 4.50; " 4.00; " 2.50; " " 0.75 " (12290.)

Animal: With a long, narrow, transparent foot, with pedal grooves as in *arboreus*, head, neck and upper part of animal black or blackish, lighter on the side of the foot; the other characters as in *arboreus*. Heart situated as in the previous species; pulsations regular and rapid, 95 per minute when contracted and 130 when extended. Length of foot 6.00, width 1.00 mill. (Shell 4.25 mill. greater diameter.)

Jaw: Strongly arched, wide, roundly pointed at the ends, which are a little upturned; concave margin with a good sized, rounded median projection, and two or three smaller projections on either side (Fig. 37).

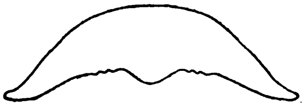

FIG. 37.

Jaw of VITREA HAMMONIS Ström. (After Morse.)

Radula formula: $\frac{24}{1}+\frac{3}{2}+\frac{1}{3}+\frac{3}{2}+\frac{24}{1}$ (27—1—27); teeth of the same general type as those of *Zonitoides arboreus;* central narrow, tricuspid; laterals of same type, but bifid; marginals aculeate. There are about 55 rows of teeth.

Distribution: North America, Europe, Asia. In North America from British America and Northern United States south to South Carolina and Colorado.

Geological distribution: Pleistocene; Loess.

Habitat: Same as *Zonitoides arboreus* and usually associated with that species.

Remarks: This species is very closely related to *Zonitoides arboreus* but may be distinguished by its darker color, the more rapid enlargement of the last whorl and its different shape when viewed from the aperture. As in *Z. arboreus* the head and neck are carried far in advance of the shell, when in motion. This is also a common species, although not as numerous in individuals as *Z. arboreus*. It seems to occupy about the same localities as that species.

SECTION GLYPHYALINIA Martens, 1892.

68. **Vitrea indentata** Say, pl. xxviii, fig. 11.

Helix indentata SAY, Journ. Phil. Acad., Vol. II, p. 372, 1822.
Hyalinia subrupicola DALL, Bull. U. S. Geol. and Geogr. Surv. of Terr., Vol. III, p. 163, 1879.
Zonites indentatus var. *umbilicatus* SINGLEY, British Naturalist, April, 1893, p. 81.

Shell: Small, depressed, thin, pellucid, subperforated, frequently almost imperforate; surface shining, polished, covered with strong, impressed striæ which are equidistant, the spaces on the last whorl being much wider than the striæ; color, yellowish or dark horn; periphery rounded; sutures impressed; whorls four and one-half, rapidly increasing, the outer whorl rapidly enlarging as it approaches the aperture; spire flat, a little convex; aperture large, transversely oval; peristome simple, thin, acute, the lower portion extending clear to the umbilicus; umbilicus not perforated, but the region is strongly indented; base of shell convex (Fig. 36).*

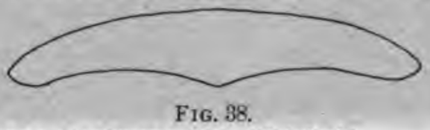

FIG. 38.
Jaw of VITREA INDENTATA Say. (Original.)

Greater diameter, 5.00; lesser, 4.50; height, 2.50 mill. (10221.)
" " 5.00; " 4.50; " 2.75 " (10222.)

Animal: Similar to *Z. arboreus* and *V. hammonis;* blackish above, lighter below and on the sides; foot 9 mill. long, 2 mill. wide, shell 5 mill., greater diameter. Heart as in the other species of the genus, pulsations regular, 160–162 beats per minute. When the animal is emerging from the shell the heart almost stops beating.

Jaw: Long, narrow, somewhat bow-shaped, ends bluntly pointed; upper margin rounded, lower margin with a broad, median projection (Fig. 38).

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*These figures are introduced to enable the student to perceive the differences between these minute shells.

Radula formula: $\frac{36}{1}+\frac{3}{2}+\frac{1}{3}+\frac{3}{2}+\frac{36}{1}$ (39—1—39); teeth of the same type as others of the genus; central tooth longer than wide, the base of attachment with widely expanded lower outer corners, tricuspid, the central cusp very long and reaching much below the edge of the base of attachment, side cusps small; lateral teeth similar to central, bicuspid; marginals aculeate, the first one or two modified. There are about the same number of rows as in *hammonis*.

Distribution: Canada to Texas; Dakota to Maine and Florida; "Lower California and states of Jalisco and Morelos, Mexico." (Pilsbry.) Manitoba (Hanham).

Geological distribution: Pleistocene; Loess.

Habitat: Same as *arboreus* and *hammonis*.

Remarks: This species may be distinguished from the last by its subperforate umbilicus and peculiar equidistant impressed striæ. The two species, though resembling each other when casually viewed, are readily separated when the characters are once understood. The animal is very rapid and more bold than the other species. *Indentata* is as widely distributed as the last species, but is not nearly as common, only a few individuals being found together.

GENUS **EUCONULUS** Reinhardt.

Conulus, FITZ, 1833; non *Rafinesque*, 1814 (vide Pilsbry, The Nautilus, Vol. XIV, p. 81).

"*Shell:* Imperforate, or very narrowly perforate, turbinate, arcti-spiral; whorls 5 to 6, rather convex; aperture depressed-lunar, the penultimate whorl strongly excided, somewhat oblique. Peristome with margin separated."

"*Animal* (of *C. fulvus*)*:* Bluish-black upon the head, neck, and eye-peduncles, lighter on the sides and base; foot very narrow, thread-like. A distinct caudal mucus pore." (Binney.)*

69. **Euconulus fulvus** Draparnaud, pl. xxviii, fig. 17.

Helix fulva DRAPARNAUD, Hist. Moll., 1805.

Helix egena SAY, Journ. Phil. Acad., Vol. V, p. 120, 1825.

Conulus fulvus mortoni JEFFREYS (vide Pilsbry). (Variety.)

Conulus fulvus alaskensis PILSBRY, The Nautilus, Vol. XII, p. 116, 1899. (Variety.)

Shell: Subconical, turreted, thin, pellucid, convex above, rounded below, subperforate; surface shining, smooth, marked by very fine, oblique, crowded growth lines, which disappear on the large, rounded, flat nucleus; color light yellowish-horn; periphery rounded; sutures deeply impressed; whorls six, narrow, rounded, very regularly increasing; spire generally elevated, sometimes a little depressed, convex; aperture transverse, wider than high, somewhat moon-shaped in some specimens, contracted by the body-whorl; peristome thin, acute, simple, the terminations widely separated; umbilical region indented, but the umbilicus closed or minutely perforated, base rounded; last whorl angular in front, the angularity becoming obsolete on the latter part of the whorl.

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*W. G. Binney, Man. Amer. Land Shells, p. 67.

Greater diameter, 2.25; lesser, 2.00; height, 1.75 mill. (10648.)
" " 2.75; " 2.25; " 1.75 " (10647.)
" " 2.90; " 2.50; " 2.00 " (10107.)
" " 3.00; " 2.50; " 2.50 " (12295.)
" " 3.00; " 2.80; " 2.75 " (Coll. Jensen.)

Animal: With a long and narrow foot, with distinct caudal mucus pore and pedal grooves; tentacles short and blunt; eye-peduncles long and tapering; color blackish on head, neck and eye-peduncles, rest of body dirty white; a black stripe extends from each eye-peduncle over the back to the shell. When viewed dorsally the animal is almost hidden by the shell, which is large in comparison with the foot. Heart situated near the umbilical region, pulsations variable, ranging from one hundred and thirty-five to one hundred and fifty per minute. As in all mollusks, warmth accelerates the action of the heart. A specimen measuring 4 mill. in length was almost jet black in color.

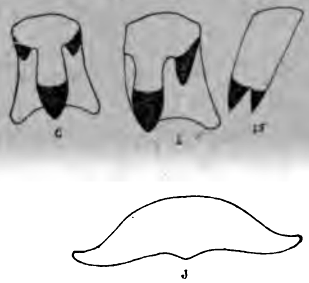

FIG. 39.

Teeth of EUCONULUS FULVUS Drap. (Original.) c, central tooth; 1, first lateral; 15, fifth perfect marginal; J, jaw.

Jaw: Strongly arched, very wide in the middle and tapering at either end, which is rather pointed; margins smooth, no ribs; inferior margin with a large, well-developed median projection (Fig. 39, J).

Radula formula: $\frac{18}{2}+\frac{2}{2}+\frac{8}{2}+\frac{1}{3}+\frac{8}{2}+\frac{2}{2}+\frac{18}{2}$ (28–1–28); central tooth with a base of attachment almost as wide as high, much produced at the outer, lower corners; reflection tricuspid, the central cusp very long, reaching below the edge of the base of attachment, wide, the side cusps short and wide; lateral teeth similar to central tooth, but the inner lower angle of the base of attachment suppressed and the reflection bicuspid, the inner cusp long, reaching below the base of attachment, and the outer cusp short, but longer than in the central tooth; the transition teeth similar to the laterals but the cusps shortening and becoming more equal; marginal teeth narrow, long, bicuspid, the cusps of equal size. All of the teeth have well-developed cutting points (Fig. 39). There are about 80 rows of teeth.

Genitalia: Unknown.

Distribution: Europe, Asia, United States south to Texas; Southern Canada and Alaska. Palæarctic.

Geological distribution: Pleistocene; Loess.

Habitat: Found associated with *Zonitoides arboreus*, *Punctum pygmæum*, *Bifidaria curvidens*, etc., under stones and sticks, in old and rotting logs. It requires a moist locality.

Remarks: This is one of our most common mollusks. The specimens from this region are very constant, exhibiting little or no variation, and may be easily known by their rounded spires and closely coiled whorls. The animal is rather shy and crawls about with a wabbly motion as though the shell were too heavy for it. The writer has found it particularly abundant in the woods about Bowmanville, under and crawling over chips and fallen pieces of bark. Prof. Pilsbry has shown* that there are two species of Conulus which are generally mixed together, viz., the present species and *C. chersinus* Say, which is a shell with a much more turreted spire and more closely coiled whorls. The teeth of the two species are widely different, the present species having the formula 28–1–28 (original), 30–1–30 Binney, while *chersinus* has 18–1–18 according to Morse. I feel certain that Morse had *chersinus* when he examined the dentition, for the reason that a number of personal examinations of undoubted fulvus *all* gave 28–1–28. The present species is found throughout the area.

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*The Nautilus, Vol. XII, p. 113.

Subfamily Ariophantinæ.

GENUS ZONITOIDES Lehmann.

Whorls rounded below, polished; aperture without callus; otherwise similar to Gastrodonta.

KEY TO SPECIES OF ZONITOIDES.

A. Shell large, polished, smooth.
  1. Shell 6–7 mill. in diameter, spire elevated; aperture lunate . . *nitidus*
  2. Shell 5 mill. in diameter, spire depressed; aperture transversely rounded . . . . *arboreus*

B. Shell small, striated.
  1. Shell less than 3 mill. in diameter, umbilicus spreading, not deep . . . . *minusculus*

70. Zonitoides nitidus Müller, pl. xxviii, fig. 16.

Helix nitida MÜLLER, Hist. Verm., Vol. II, p. 32, 1774.

Helix hydrophila, INGALLS, Mss.

Shell: Orbicularly depressed, thin, umbilicated; surface shining, covered with rather strong lines of growth; color smoky-horn; periphery rounded; sutures impressed; whorls five, convex, regularly increasing, except the last, which is very large in proportion, and obtusely angled on the periphery as it approaches the aperture; spire rather elevated, convex; aperture lunate, oblique; peristome simple, acute, the basal margin bow-shaped; terminations of aperture not approaching; umbilicus round, broad, deep, exhibiting the volutions to the apex; base of shell concave about the umbilicus, convex on the last whorl.

Gr. diam., 6.00;	lesser, 5.00;	height, 4.00;	umbilicus diam., 1.25 mill.	(10224.)
" 6.25;	" 5.50;	" 3.00;	" 1.50 "	(12294.)
" 6.00;	" 5.00;	" 3.00;	" 1.25 "	(12224.)

Animal: Blackish or grayish, otherwise similar to *Z. arboreus* Say. The heart is situated in a direct line with the inferior portion of the peristome, to the left of the umbilicus; pulsations regular, one hundred and one per minute when crawling on glass and one hundred and twenty-three to one hundred and thirty-eight when held in the hand; holding the shell in the hand seems to irritate or excite the animal, and cause the pulsations to increase. Length of foot when extended 9.00 mill., width 1.50 mill.

Jaw: Similar to that of *arboreus*.

Radula formula: $\frac{19}{1}+\frac{5}{2}+\frac{1}{3}+\frac{5}{2}+\frac{19}{1}(24-1-24)$; central tooth with a base of attachment which is longer than wide; reflected portion tricuspid, the central cusp very long, the side cusps very short; lateral teeth (five in number) similar to centrals, but bifid, with the inner cusp the longest; marginals aculeate. The cusps all have well-developed cutting points. The radula is similar in type to that figured under *Z. arboreus.*

Distribution: Circumpolar. Northern United States and British America, Northern Europe and Asia. Introduced into the United States.

Geological distribution: Pleistocene; Loess.

Habitat: Same as *Z. arboreus.*

Remarks: This is a neat little species, distinguished from its congeners by its large size, elevated spire and its rounded aperture. It, like *arboreus,* loves company, and is always found in little colonies. The animal is peculiar in being so very black. It is widely distributed.

71. **Zonitoides arboreus** Say, pl. xxviii, fig. 9.

Helix arborea SAY, Nich. Encycl., pl. iv, fig. 4, 1816; BINNEY'S ed., p. 5, pl. lxxii, fig. 5.
Helix ottonis PFEIFFER, Olim. Weigm. Arch., Vol. I, p. 251, 1840.
Helix breweri NEWCOMB, Proc. Cal., Acad. Sci., Vol. III, p. 118, 1864.
Hyalina viridula COCKERELL, Science Gossip, p. 257, 1889.

Shell: Depressed, thin, umbilicated; surface shining, the lines of growth being so fine that the surface appears smooth unless examined with a powerful glass; color amber, sometimes whitish; periphery rounded; sutures impressed; whorls five, regularly and evenly increasing, rounded; spire depressed, a trifle convex; aperture rounded, a little transverse; peristome simple, thin; umbilicus deep, narrow, the region indented; base of shell convex (see Fig. 36).

Gr. diam., 5.00;	lesser, 4.75;	height, 2.75;	umbilicus diam., 0.75;	mill.	(10095.)
" 5.25;	" 5.00;	" 3.00;	" 0.85;	"	(10649.)
" 5.00;	" 4.50;	" 2.50;	" 0.85;	"	(10096.)
" 5.00;	" 4.50;	" 3.00;	" 1.00;	"	(10098.)

Animal: With a long, narrow, transparent foot, with longitudinal furrows; head, neck and eye-peduncles jet black, the rest of the body white and transparent except near the upper part, where it is bluish; eye-peduncles long and slender, with the eyes at their extremity; inferior tentacles very short, blunt; length of foot 6.00 mill.; width 0.75; pedal grooves and mucus pore, as usual in the genus; eye-peduncles 2 mill. in length (shell 5 mill. in greatest diameter). The heart is situated to the left of the aperture on the outer edge of the body-wall. The pulsations are rapid and regular; one hundred pulsations per minute were counted when the animal was contracted, and one hundred and forty-eight to one hundred and sixty when it was extended.

Jaw: Long, narrow, bow-shaped, the ends bluntly pointed; upper margin with a median depression, lower margin with a very wide, blunt median projection (Fig. 40, J).

Radula formula: $\frac{3}{1}+\frac{8}{2}+\frac{5}{2}+\frac{1}{3}+\frac{5}{2}+\frac{8}{2}+\frac{3}{1}$ (16–1–16); central tooth squarish, a little longer than wide, tricuspid, the central cusp very long and wide and reaching below the base of attachment, lateral cusps short; lateral teeth five in number, similar to central, but bicuspid, the inner cusp very long, the outer cusp short; marginal teeth eleven in number, thorn-shaped, all but the first three (which are bicuspid, the outer cusp being very small) unicuspid; the teeth decrease in size as the side of the membrane is approached (Fig. 40). There are about 80 rows of teeth. Morse gives 21–1–21 teeth.

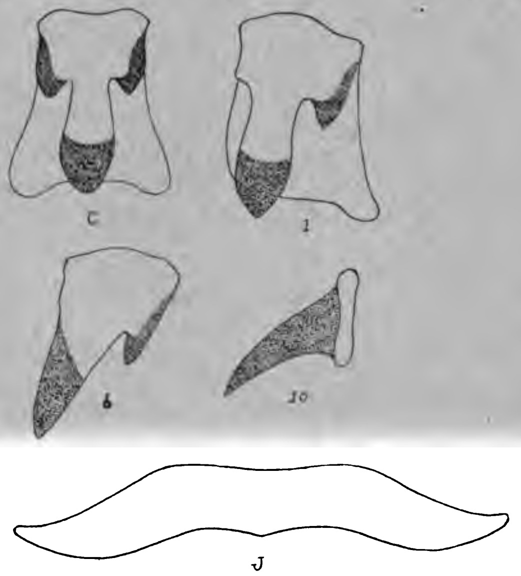

FIG. 40

Radula of ZONITOIDES ARBOREUS Say. (Original.) c, central tooth; 1, first lateral; 6, first marginal; 10, fifth marginal; J, jaw.

Distribution: Entire United States; British America.

Geological distribution: Pleistocene; Loess.

Habitat: Found plentifully under dead leaves, rotten logs, in crevices of rotting wood, and under the bark of fallen, rotten logs.

Remarks: This is the most common of our small land snails. When in progression the shell is carried on the back at an angle of 45 degrees, tipping to the left side of the body, and the head and neck are stretched far in advance of the aperture of the shell. The eye-peduncles are always nervously thrust about as though searching for danger, and the least noise or jar will cause them to be drawn into the body. *Arboreus* is infested by a curious parasite, *Distoma appendiculata* Leidy,* which is sometimes found in considerable numbers. *Arboreus* is more widely distributed than any other (excepting, perhaps, *Pyramidula alternata*) in this region, and there is probably not a single locality where it is not found. It loves company and is generally found by the dozen under the bark of decaying trees or under chips of wood.

SECTION PSEUDOHYALINA Morse.

Surface of shell strongly striated.

72. **Zonitoides minusculus** Binney, pl. xxviii, fig. 12.

Helix minuscula BINNEY, Bost. Journ. Nat. Hist., Vol. III, p. 435, pl. xxii, fig. 4, 1840.
Helix minutilis MORELET, nec. FERUSSAC, Test. Nov., Vol. II, p. 7.
Helix apex ADAMS, Contr. Conch., p. 36.
Helix lavelleana D'ORBIGNY, Moll. Cub., in text, p. 161, excl. pl. 1853.
Helix mauriniana D'ORBIGNY, l. c., in pl. viii, figs. 20–22, excl. text. 1853.
Zonites minusculus var. *alachuana* DALL, Proc. U. S. Nat. Mus., p. 270, 1885. (Variety.)

Shell: Small, depressed, thin, umbilicated; surface shining, lines of growth strong; color white, periphery rounded; sutures deeply impressed; whorls four, convex, slowly and regularly increasing in size; spire almost flat, a trifle convex; aperture very nearly circular, not expanded; peristome simple, acute, the basal margin rounded; terminations of aperture not approaching; umbilicus very large, deep, exhibiting all the volutions to the apex; columella with a thin, testaceous deposit; base of shell convex (see Fig. 36).

Greater diameter, 1.50; lesser, 1.30; height, 0.75 mill. (10235.)
" " 2.50; " 2.10; " 0.75 " (12293.)

Animal: With a narrow foot of medium length; eye-peduncles not very long, cylindrical; color bluish-white; mucus pore placed on the upper surface of the extremity of the foot; pedal grooves distinct.

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*Proc. Phil. Acad., p. 202, 1877.

Jaw: Similar in shape to that of *Vitrea indentata*, with a broad, inconspicuous median projection (see Fig. 38).

Radula formula: $\frac{8}{1}+\frac{1}{1}+\frac{3}{2}+\frac{1}{3}+\frac{3}{2}+\frac{1}{1}+\frac{8}{1}$ (12—1—12); teeth similar in form to those of *arboreus*, excepting that they are a little wider; the fourth lateral is modified. There are over 50 rows of teeth.

Distribution: "Ontario to Florida, west to Montana, Arizona and New Mexico, Bermuda." (Pilsbry.) West Indies, Japan. (Binney.) Manitoba. (Hanham.)

Geological distribution: Pleistocene; Loess.

Habitat: Found in and about rotting logs in damp woods.

Remarks: A common species, distinguished by its small size, flattened spire and very wide umbilicus. The animal is very timid in captivity, hesitating a long time before starting to crawl over the surface upon which it has been placed. Like the Vitreas which it somewhat resembles, this little species is widely distributed, and will ultimately be found to be as common as *Z. arboreus*, when all parts of the area are thoroughly explored.

GENUS **GASTRODONTA** Albers.

Gastrodonta ALBERS, Die Helicien, p. 88; Malak. Blätter, Vol. IV, p. 91, 1857.

Ventridens BINNEY & BLAND, Land and Fr. Wat. Shells, N. A., Part I, p. 292, 1869.

Shell: Usually umbilicated, rather thin; horn-colored, glassy, covered with coarse striæ; whorls five to seven; aperture lunate, exhibiting two modifications: (1) with teeth or laminæ on the base (*gularis* Say); (2) with a strong white callus on the floor of the last whorl (*ligera* Say); peristome simple, acute.

Animal: Generally blackish; head, neck and eye-peduncles much darker, the latter very long; mucus pore a longitudinal furrow, situated on the upper surface of the extremity of the foot, and opened and closed at will. Locomotive disk furrowed above the margin of the foot. Genitalia provided with a dart sac, in which is contained a long, curved, calcareous dart upon the vagina.*

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*Pilsbry, Proc. Phil. Acad., 1894, p. 16.

Distribution: Europe and America.

KEY TO SPECIES OF GASTRODONTA.

A. Shell depressed, spire almost flat .... *demissa*
B. Shell globular, spire much elevated .... *ligera*

73. Gastrodonta ligera Say, pl. xxviii, fig 14.

Helix ligera SAY, Journ. Phil. Acad., Vol. II, p. 157, 1821.

Helix rafinesquea FERUSSAC, Tab. Syst., p. 50; Hist. pl. li, a, fig. 5; pl. l, a, figs. 4, 5, 1822.

Helix wardiana LEA, Trans. Amer. Phil. Soc., Vol. VI, p. 67, pl. xxiii, fig. 82, 1839.

Gastrodonta ligera stonei PILSBRY, The Nautilus, Vol. III, p. 46, 1889. (Variety.)

Shell: Umbilicated, orbicular, convex; epidermis shining, straw-colored or yellowish-horn color, deep yellow on the base of the last whorl, the color frequently running high up toward the suture; whorls seven, covered with closely crowded, transverse striæ, which disappear on the base of the shell; umbilicus small, rounded and deep, appearing to extend clear to the apex of the shell; umbilical region impressed; sutures impressed; aperture rounded, semilunate, the base and side of the last whorl being covered by a thick, white deposit of testaceous matter, greatly thickening that portion of the shell; peristome thin, acute; spire elevated, exhibiting nearly all the whorls in a lateral view.

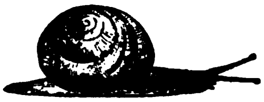

FIG. 41.

Animal of GASTRODONTA LIGERA Say. (Binney, fig. 68.)

Gr. diam., 12.00; lesser, 11.00; height, 9.50; umbil. diam., 1.00 mill. (8460.)
" " 8.75; " 8.00; " 6.50; " " 0.75 " (8461.)

Animal (Fig. 41): With a long and narrow foot, acutely pointed behind; color slaty-black on the upper surface, lighter on the base and posterior extremity, grayish on the collar; eye-peduncles tapering, slender, rather long, eyes placed as usual; other characters as described for the genus.

Jaw: Not examined. Said by Binney to be "strongly arcuate, ends rounded; anterior surface striated; concave margin with a well-developed median projection."

Radula formula: $\frac{2,4}{1}+\frac{1,4}{2}+\frac{1}{3}+\frac{1,4}{2}+\frac{2,4}{1}$ (38—1—38); centrals tricuspid, the central cusp long, the side cusps short; lateral teeth similar, but bicuspid, the inner cusp the longest; marginal teeth aculeate. The teeth are similar in type to those of the Zonitidæ.

Genitalia: Genital bladder "small, oval, on a long, delicate duct, from about the middle of the length of which there is a connecting duct to the middle of the penis sac and a second duct to the apex of the dart sac." Penis long, large near the vagina, "tapering above, and furnished below its apex with an accessory, short, delicate, cylindrical gland, terminating in a small pyriform bulb. The dart is long, delicate, strictly arrow-shaped with pointed, enlarged head and much thickened at the posterior termination. The penis sac is stout, short, receiving at its apex the vas deferens, on the commencement of which the retractor muscle is inserted."*

Distribution: Ontario, Canada, to Michigan, south to Indian Territory, Louisiana, Virginia and Tennessee. (Pilsbry.)

Geological distribution: Pleistocene of the Mississippi Valley; Loess.

Habitat: Found rather sparingly in moist situations near bodies of water of greater or lesser size. Prefers the under side of old logs and the depths of dead brush heaps.

Remarks: Easily recognized by its globose form, somewhat elevated spire and deeply impressed base. It is not a common species, and, so far as known, is confined to the southern region, about the chain of lakes.

74. Gastrodonta demissa Binney, pl. xxviii, fig. 6.

Helix demissa BINNEY, Bost. Journ. Nat. Hist., Vol. IV, p. 361, pl. xvi, fig. 16, 1843.

Gastrodonta demissa brittsii PILSBRY, The Nautilus, Vol. XI, p. 132, 1898. (Variety.)

Shell: Umbilicated, depressed, convex; epidermis as in *ligera;* whorls six, covered with coarse, closely crowded, transverse striæ, disappearing on the base; umbilicus small, round, deep; umbilical region impressed; suture impressed; aperture transverse, oblique, the base of the last whorl with a deposit as in *ligera;* peristome thin, acute; spire very much depressed, so that all the whorls cannot be seen when viewed laterally; base of shell flat, smooth; last whorl but little expanded toward the aperture.

Greater diameter, 8.50; lesser, 7.25; height, 4.00; umbilicus diameter, 0.50 mill. (8459.)

Animal: Not differing in general form from *ligera;* color dirty white, blackish or bluish on head, tentacles and eye-peduncles; pedal grooves and mucus pore as in *ligera*.

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*W. G. Binney, Man. Am. Land Shells, p. 214.

Jaw: Similar to that of *ligera*.

Radula formula: $\frac{30}{1}+\frac{15}{2}+\frac{1}{3}+\frac{15}{2}+\frac{30}{1}$ (45—1—45); characters of the teeth not differing essentially from those of *ligera*.

Genitalia: Differing from *ligera* in having a second accessory pyriform gland to the dart sac. (Binney.)

Distribution: Western Pennsylvania to Georgia, west to Arkansas and eastern Texas. (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Same as that of *ligera*.

Remarks: Distinguished from *ligera* by its smaller size, more depressed spire and transverse aperture. This is not a common species and seems to be confined to the southern region, as no specimens have thus far been collected in any other part of the territory.

FAMILY LIMACIDÆ.

"Shell rudimentary, a calcareous plate, not spiral, concealed under the mantle, and covering the respiratory cavity. Foot with or without mucus pore; jaw oxygnathous, arcuated, without ribs, with a rostriform projection on the inferior margin; lingual plate with a tricuspidate central tooth, the middle cusp long and narrow, laterals bi- or tricuspidate, marginals narrow, sharp, uni- or bicuspidate." (Tryon.)*

GENUS **LIMAX** Linné, 1758.

"Animal attached its whole length to the foot, subcylindrical, tapering behind, bluntly truncate anteriorly; tentacles simple; mantle small, anterior, enclosing a shelly plate; no caudal mucus pore; a distinct locomotive disk; external anal and respiratory orifices at the right posterior margin of the mantle; orifice of combined generative organs behind and below the right peduncle."

"Shell-plate testaceous, thin, flat, longer than wide, with concentric striæ of increase, internal."

"Jaw smooth with median projection. Lingual membrane long and narrow; central teeth tricuspid, laterals bicuspid, marginals aculeate, often bifid. Considerable variation is found in the dentition of the genus; the centrals and laterals are sometimes unicuspid." (Tryon.)*

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*Struct. and Syst. Conch., Vol. III, p. 78.

Genitalia (Fig. 42): Testicle round or oval, partially concealed by the liver, brown in color and apparently composed of rounded acini (lobulated in *flavus*); epididymis an undulating tube leading from the testicle to the inner side of the junction of the ovary with the prostate gland, and opening into a groove in the oviduct, which is continuous at its inferior extremity with the vas deferens; prostate gland whitish, striated in appearance, occupying the inner side of the whole length of the oviduct; vas deferens comparatively short, passing from the prostate gland to the penis, in some forms (*maximus*, *flavus*, etc.) joining the latter at its summit, and in others (*agrestis* and *campestris*) at its base; penis generally long, cylindroid and irregular, lying at the right anterior part of the visceral cavity, and joining at its termination a short cloaca; a retractor muscle is inserted into its summit, which arises from the muscular investment of the visceral cavity, posterior to the position of the pulmonary cavity; in some species the penis

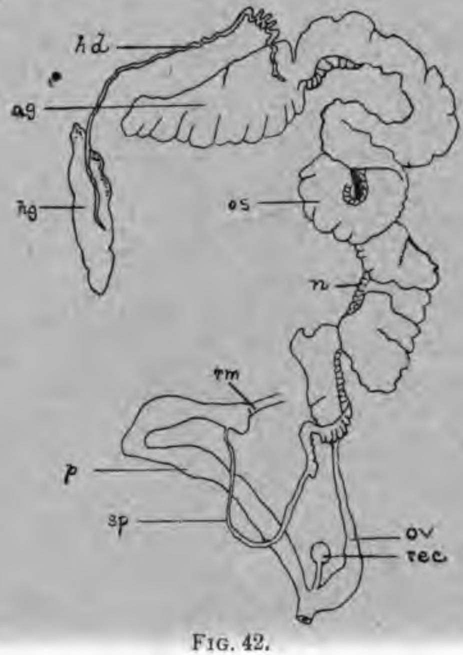

FIG. 42.

Genitalia of LIMAX MAXIMUS Linné. (After Scharff.) ag, albuminiparous gland; hg, ovotestis; hd, hermaphrodite duct (epididymis); n, prostate gland; os, uterine portion of hermaphrodite duct; sp, vas deferens; rm, retractor muscle; ov, oviduct; p, penis; rec, receptaculum seminis.

is elongate-conical (*agrestis*) and in others spiral (*campestris*); ovary large, white, semi-elliptic, more or less curved and lobulated, placed at the summit of the oviduct, which is a long, wide, soft, white, tortuous, sacculated tube, passing from the ovary to the vagina; generative bladder generally large, pointed and oval, opening by a short, wide duct into the vagina; in *agrestis* it is large, elongated, oval, and opens by a short duct into the angle formed by the junction of the vagina with the male portion of the generative apparatus; in *campestris* it is a small oval sac, with a longer, narrow duct, opening into the tube leading from the penis to the cloaca.* The character of the generative apparatus differs considerably in the various species, and will be treated under each.

Distribution: World-wide.

KEY TO SPECIES OF LIMAX AND AGRIOLIMAX.

A. Slug large.
  a. Tubercles inconspicuous; color arranged on body in longitudinal stripes, dots or dashes, *black*............*maximus*
  b. Tubercles large and conspicuous, body with oblong-oval, *uncolored* spots..................................*flavus*
B. Slug small.
  a. Body of various shades of amber, or blackish, without spots or color markings........................*campestris*

75. Limax maximus Linné, pl. xxviii, figs. 3, 8.

Limax maximus LINNE, Syst. Nat., 1758.

Limax antiquorum FERUSSAC, Podr. 20; Hist., p. 68, pl. iv, pl. viii, A, fig. 1, 1819.

(*Vulgaris* Moq., *cellarius* D'Argentville, *maculatus* Picard.)

Shell: Elongately quadrate, thin, silvery white in color, convex lines of growth rather coarse. Length, 13.00 mill.; width, 7.00 mill. (9316.) The shell is only a rudiment and protects the lungs (Fig. 3).

Animal: With an elongated body, with a strong dorsal carina terminating the posterior end and covered with longitudinal, elongated tubercles of large size; color ashy or light brown, with several uninterrupted black stripes extending from the mantle to the posterior end, and with numerous alternate rows of round spots, which are placed longitudinally; the sides are much lighter in color and the foot and under parts are dirty white; mantle large, oval, with the tubercles arranged concentrically, color light brown with irregular blotches of black scattered over the surface; respiratory orifice very large, situated on the right side near the posterior end of the mantle; locomotive disk narrow; tentacles short, blackish, blunt, placed very near the lower surface; eye-peduncles long, tapering, rather stout, the eyes placed on prominences at the tip, eyes blackish; animal exuding mucus from its entire surface (Fig. 8).

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*W. G. Binney, Man. Amer. Land Shells, p. 236.

Length, 167.00; width, 19.00; height, 13.00 mill. (10091.) Animal fully extended.

Jaw: Long, arched, narrow, ends attenuated and rounded; cutting edge with a strong median projection, and a central vertical carina or ridge; striated longitudinally and vertically (Fig. 43, J).

Radula formula: $\frac{13}{1}+\frac{45}{2}+\frac{17}{3}+\frac{1}{3}+\frac{17}{3}+\frac{45}{2}+\frac{13}{1}$ (75—1—75); central tooth with a subquadrate base of attachment, with the

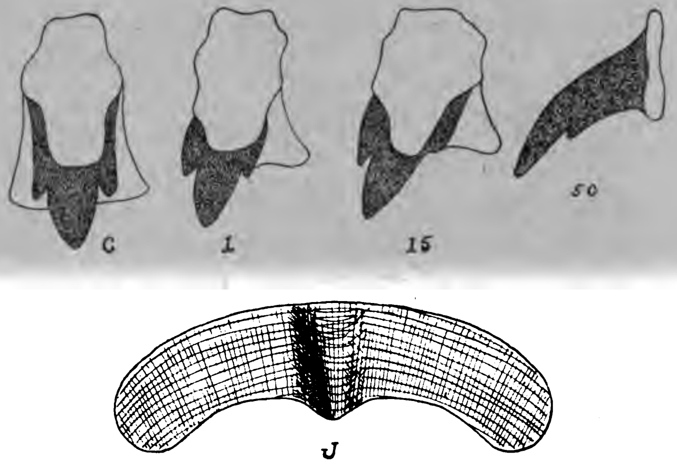

FIG. 43.

Radula of LIMAX MAXIMUS Linné. (Original.) c, central tooth; 1, first lateral; 15, fifteenth lateral tooth; 50, thirty-third marginal tooth; J, jaw.

lower, outer corners attenuated; reflected portion large, longer than wide, the cutting point about half the length of the reflection, and trifid; lateral teeth 17 in number, similar to central tooth; marginals of the aculeate type, the first forty-five being bifid and the last thirteen of the pure aculeate form (Fig. 43).

Genitalia: "With a strongly lobulated ovary; penis sac long, cylindrical, tapering to its apex, where it receives the retractor muscle and the vas deferens; genital bladder small, on a short duct."

"The eggs are globular, transparent, over two hundred in number, laid in a compact mass."*

Distribution: Europe, Asia Minor, Corsica, Sicily, Sardinia, Azores, Madeira, New Zealand and United States. (Introduced.)

Habitat: Found principally in greenhouses under boards and along the sides of the drains. In Rochester, N. Y., the species is found plentifully under board sidewalks and in cellars, in any part of the city. In Europe it is solitary in habit and is found chiefly in the woods, under fallen trees and stones and near the seashore.†

Remarks: The present species is the largest of the genus and is a voracious eater. Its food consists principally of fungi, or, if living in a cellar, of meat and vegetables. It is said to rarely eat green plants (vide Scharff). Instances are known of its committing cannibalism, especially when very hungry and when several specimens are together. The writer has several times noted a peculiarity in the mucus of this slug, viz., that it is sticky and will entangle the legs of flies or other insects which alight upon the animal, and will act in the same manner as fly-paper. Several flies have been noted in this predicament. This species, as well as others of the genus, is principally nocturnal in habit. Like *Vitrea draparnaldi* it has been introduced from Europe. It has not been detected, as yet, outside of the greenhouses, where, however, it may be found in considerable numbers.

76. **Limax flavus** Linné, pl. xxviii, fig. 27.

Limax flavus LINNÉ, Syst. Nat., ed. X, Vol. I, p. 652, 1758. (non Müller, 1774.)

Limax variegatus DRAPARNAUD, Tab. Moll., p. 103 (1801).

Shell: Rudimentary, oblong-oval, thin, concave below, convex above; upper surface covered with a delicate periostracum. The plate increases in thickness with age.

Animal: Brownish or yellowish-brown in color, ornamented by numerous oval or oblong spots without color; mantle rather large, oval, rounded before and behind, spotted with large rounded blotches, and marked with fine, concentrical striæ; eye-peduncles long, slender, tapering, blue in color and semi-transparent; head and neck of same color as eye-peduncles; tentacles short, white; general form of body

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* Binney, Man. Amer. Land Shells, p. 451.

† Scharff, The Slugs of Ireland, Sci. Trans. Roy. Dub. Soc., Vol. IV, Series II, No. 10, 1891.

(when extended) elongate cylindrical, with a short, prominent keel; dorsal portion of body covered with numerous long, narrow, well-marked tubercles; foot long and narrow, yellowish white in color; sides of body without spots. The spots sometimes extend down the center of the back.

Length, 86.00; width, 10.00 mill., extended. (9355.)

Jaw: Strongly arched, horn-colored, anterior surface with a strong carina; ends square or only slightly rounded; concave margin smooth, with a well-marked median projection; anterior surface strongly striate vertically, and faintly striate longitudinally (Fig. 44).

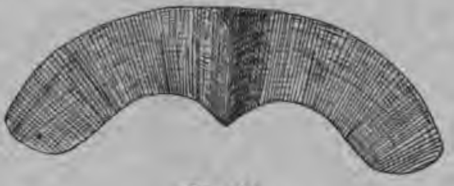

FIG. 44.
Jaw of LIMAX FLAVUS Linné. (After Binney.)

Radula formula: $\frac{44}{2}+\frac{16}{3}+\frac{1}{3}+\frac{16}{3}+\frac{44}{2}$ (60–1–60); the teeth are in all essential respects like those of *maximus*, except that the cutting points are longer. There are about 100 rows of teeth.

Genitalia: "The testicle, composed of a globular mass of aciniform cœca, is not imbedded in one of the lobes of the liver. The penis sac is long, stout, cylindrical, receiving the vas deferens and the retractor muscle at its apex. The genital bladder is small, elongated-ovate, with pointed apex and short duct." (W. G. Binney.)

Distribution: Same as *maximus*, with the addition of Balearic Islands, Brazil and Australia.

Habitat: Similar to *maximus*, but not so common.

Remarks: This species is at once distinguished from *maximus* by the absence of color spots and by the larger size of the tubercles. It is an introduced species and is fast spreading over the United States. Its habits are like those of *maximus*.

GENUS **AGRIOLIMAX** Mörch.

"*Animal* keeled only posteriorly. Mantle concentrically striated, the center of striæ being somewhat to the right of the median line. There are no bands, and if spots are present they are irregularly scattered over the body. Pulmonary opening behind middle of mantle, and genital pore near tentacles. The intestine has four convolutions, and there is a solid internal shell; no caudal gland."*

Genitalia: Differing from Limax in having the vas deferens join the penis at its base, and in the shape of the penis and the genital bladder.

77. **Agriolimax campestris** Binney, pl. xxviii, fig. 13.
Limax campestris BINNEY, Proc. Bost. Soc. N. H., p. 52, 1841.
Limax occidentalis J. G. COOPER, Proc. Phil. Acad., p. 146, pl. iii, fig. C, 1872.
Limax montanus INGERSOLL, Bul. U. S. Geol. and Geogr. Surv. of Terr., No. 2, Second Ser., p. 152, 1875.
Limax castaneus INGERSOLL, l. c.; ed. 2, p. 396, 1876.
Limax ingersolli W. G. BINNEY, Proc. Phil. Acad., 1875.
Limax campestris, form *intermedius* COCKERELL, The Nautilus, Vol. III, p. 100, 1890.
Limax campestris, form *tristis* COCKERELL, l. c., p. 100, 1890.
Limax hyperboreus WESTERLUND, Sibirien Land och Sötvatten Mollusker, p. 21.

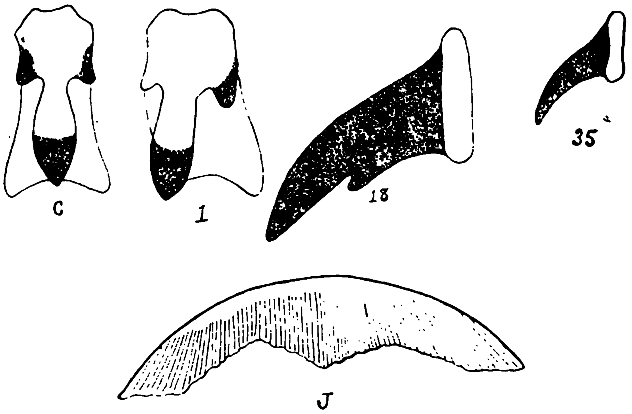

FIG. 45.

Jaw and radula of AGRIOLIMAX CAMPESTRIS Binney. (Original.)

Shell: Rudimentary, very small and fragile.

Animal: With a long and narrow body, terminating posteriorly in a short carina and covered dorsally with large, elongated tubercles; color blackish, without spots, lighter on head and eye-peduncles; foot whitish, long and narrow; mantle not prominent, oval, ornamented with fine, concentric lines; eye-peduncles not long, cylindrical, the black eyes at their tips;

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* Scharff, Slugs of Ireland, p. 525.

respiratory orifice situated on the right side of the body, near the posterior margin of the mantle; exudes mucus as in *L. maximus.*

Length, 25.00; width, 3.00; height, 2.50 mill. (9308) extended.

Jaw: Arched; ends pointed; median projection sharp and anterior border generally serrated; anterior surface striate (Fig. 45, J).

Radula formula: $\frac{1\,1}{1}+\frac{1\,2}{2}+\frac{1\,3}{3}+\frac{1}{3}+\frac{1\,3}{3}+\frac{1\,2}{2}+\frac{1\,1}{1}$ (36—1—36); central tooth longer than wide, the lower corners of the base of attachment attenuated, tricuspid, the central cusp long and spear-shaped, the side cusps small, all provided with strong cutting points; lateral teeth (thirteen perfect) similar to the central tooth, but bicuspid, or with only a faint indication of the inner cusp, the central or inner cusp the largest, and all with cutting points; marginals aculeate, the first twelve bifid and the balance thorn shaped (Fig. 45).

Distribution: Northern and Central parts of the United States, Canada, Alaska and Siberia; Santa Fe, New Mexico.*

Habitat: Under stones and rotting logs or old boards, either in the woods or in pastures. It is found in the greenhouses about the tanks of water.

Remarks: This is our most common and only native Limax. It appears to be distributed over the entire area under consideration. It is noted particularly for its habit of suspending itself by a thread of mucus from some object. In the woods at Bowmanville this species is very common, but two specimens are seldom found together, although every chip and piece of wood in the vicinity may support an individual.

FAMILY PHILOMYCIDÆ.

Animal limaciform. Mantle covering whole body; jaw with or without ribs, and median projection to cutting edge; lingual membrane of Helicidæ; no shell. (W. G. Binney.)†

GENUS **PHILOMYCUS** Ferussac, 1821.

Philomycus FERUSSAC, Tab. Syst., p. 15, 1821.

Tebennophorus BINNEY, Bost. Journ. Nat. Hist., Vol. IV, p. 171, 1842.

"Animal limaciform. Body somewhat flattened, terminating obtusely or in a somewhat truncated form, obtuse anteriorly. Back convex, more flat when fully extended. Integuments with irregular vermiform glands, anastomosing with each other and having a general longitudinal direction. Mantle covering the whole body. Foot expanded at its margin, and visible beyond the sides of the mantle; no locomotive disk. Respiratory orifice near the head, some way to the rear of the right eye-peduncle. Anal orifice contiguous to and a little above and in advance of the pulmonary orifice. Orifice of organs of generation behind and below the right eye-peduncle. Without terminal mucus pore. No external or internal shell." (W. G. Binney.)* Jaw arched, ends blunt, median projection strong, anterior surface with a carina and either ribbed or striate. Lingual membrane (see below). Pedal grooves present.

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*Vide Cockerell, The Nautilus, Vol. VIII, p. 57.

†Man. Amer. Land Shells, p. 53.

78. **Philomycus carolinensis** Bosc., pl. xxx, fig. 1.

Limax carolinensis Bosc, Vers de Buffon de Deterville, p. 80, pl. iii, fig. 1.
Limax togata Gould, Invert. of Mass., p. 3, 1841.
Limax marmoratus DeKay, N. Y. Moll., p. 31 (no desc.). 1839.

Shell: None.

Animal: With a long, rounded or flattened body, truncated anteriorly and obtusely pointed, and somewhat flattened posteriorly; mantle covering the entire body except a small rim on the edge of the foot; color whitish, spotted and clouded with blackish spots which form three scarcely distinguishable longitudinal bands, one in the center and one on either side; the spots are irregular and anastomose with each other in various places along the bands; the lower margin of the mantle is yellowish and the foot is yellowish-white; mouth encircled by a row of papillæ; eye-peduncles not long, stout, blackish, eyes situated on the upper part of the bulb-shaped enlargement at their extremity; tentacles short, stout, whitish, more or less conical; the cuticle is beset with numerous vermiform glands which anastomose more or less with each other, and extend in a longitudinal direction. When the animal is in locomotion these glands contract and a thin, watery mucus is exuded, giving the surface a glistening, undulatory appearance, which is peculiar to this species. The foot is not very broad and extends a trifle beyond the mantle posteriorly. Generative orifice on the right side, behind and below the eye-peduncle. Other orifices as described in the genus.

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*Man. Amer. Land Shells, p. 239.

Length, 59.00; width, 10.00 mill.

Jaw: Arched, ends blunt or slightly rounded; cutting edge with a rounded median projection; anterior surface covered with both transverse and vertical lines. The jaw is very thick (Fig. 46, J).

Radula formula: $\frac{35}{2}+\frac{21}{1}+\frac{1}{1}+\frac{21}{1}+\frac{35}{2}$ (56–1–56); central tooth with a very long and narrow base of attachment, somewhat widening at the lower extremity and with parallel lines of reinforcement on the lower portion; reflection about one-fourth to one-third the length of the base of attachment, with a short, stout cusp which bears a blunt cutting point; lateral teeth of same type, but asymmetrical, the reflection and cutting point longer, and the superior border with a peculiar tri-lobed form; the outer laterals have a single small, rather sharp outer cusp; marginal teeth a modification of the laterals, the

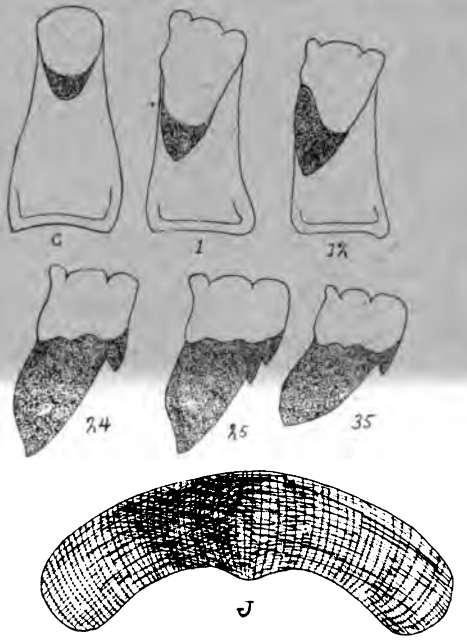

FIG. 46.

Radula of PHILOMYCUS CAROLINENSIS Binney. (Original.) c, central tooth; 1, first lateral; 12, twelfth lateral; 24, twenty-fourth marginal; 25, twenty-fifth marginal; 35, thirty-fifth marginal; J, jaw.

cutting points of the cusps being very broad and oblique, and bearing one or two small outer side cusps. (Fig. 46). There are about 115 rows of teeth.

Genitalia: "The testicle lies upon the right side, partly concealed by the liver; it is round and lobulated. The epididymis is tortuous. The vas deferens is very long, tortuous, and muscular. It joins the penis sac at its summit, and has the retractor muscle inserted into the length of the penis above the latter. The penis sac is irregularly cylindrical, bent at its summit. The ovary is exceedingly lobulated. The oviduct is tortuous, wide, and very much sacculated. The prostate gland is longer than in *Limax* or *Arion.* The generative bladder is large, globular, or nearly so. Its duct is rather less than half the length of the oviduct. At its junction with the neck of the latter an oval muscular organ exists, the dart sac. Within the latter, at the bottom, is a hemispherical papilla, upon the summit of which is placed a white, calcarate dart. At the junction of the vagina, common to the neck of the oviduct, duct of the generative bladder, and dart sac, with the penis, there are two short retractor muscles inserted. The cloaca is narrow and cylindrical, and has surrounding two-thirds of its middle a thick, glandular organ. Interiorly the penis sac, cloaca, etc., have a longitudinal rugose surface." (W. G. Binney.)*

Distribution: "Canada to Florida, west to Iowa and Texas." (Pilsbry.)

Geological distribution: Unknown.

Habitat: Under the bark of decaying trees, in forests of more or less density. Solitary in habit.

Remarks: This species is quite variable in coloration, some having the spots regularly arranged in rows, others clouded, and still others blackish, grayish, or whitish, with spots, dots or lines of color. Unlike *Limax* this species has no slit from the respiratory opening to the edge of the mantle, but has a furrow or canal of considerable depth. It ascends trees to a height of over fifty feet, and is most frequently found under bark which has become "started." So far as known it is restricted entirely to the northern region, and has only been found at Bowmanville.

FAMILY ENDODONTIDÆ.

Shell: Ribbed or striated, patuloid, umbilicated; aperture simple, or armed with folds or denticles; color horn, with various zigzag, reddish flames.

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*Man. Amer. Land Shells, p. 244.

Animal: With a well-developed caudal mucus gland and supra-pedal furrows. Genitalia lacking accessory appendages. Jaw ribbed or striated. Central tooth quadrate, with side cusps and distinct cutting points; lateral teeth similar; marginal teeth low, wide, crowded, with one or more cusps, "the outer cusp never elevated on middle cusp."*

Subfamily Endodontinæ.

"Jaw soldered into one piece." (Pilsbry.)

GENUS **PYRAMIDULA** Fitzinger, 1833.

Pyramidula FITZINGER, Syst. Verzeich, 1833.
Discus FITZINGER, Syst. Verzeich, 1833.
Patula HELD, Isis, 1837.
Anguispira MORSE, Journ. Port. Soc., Vol. I, p. 11, fig. 15, 1864.

"*Shell:* Openly umbilicated, varying in contour from flattened and disk-like to conoidal. Generally opaque, often rib-striate. Unicolored, spirally banded or flammulate. Whorls subcylindrical or keeled, the apex generally smooth. Aperture rounded-lunate; lip simple and thin."

"*Animal:* Having *the sole undivided; lateral margin of the foot with a distinct border bounded by a groove,* the grooves meeting above the tail. No caudal mucus pore. Eye-peduncles long and slender. Genital system lacking accessory organs; vas deferens and retractor muscle inserted near or at the apex of the penis; duct of the spermatheca very long; hermaphrodite duct very long, but shortened by its extreme convolution. Jaw arcuate, its component laminæ generally compactly soldered, and indicated only by fine striæ which diverge slightly from the middle. Radula (1) having only the mesocones developed upon central or inner lateral teeth, or (2) having the centrals tricuspid, laterals bicuspid lacking the ectocones, marginal teeth similar but with short basal-plates; this being the usual form. In some species the marginal teeth are multicuspid by the splitting of their ectocones." (Pilsbry.)†

KEY TO SPECIES OF PYRAMIDULA AND HELICODISCUS.

A. Shell large.
    a. Subglobose, periphery rounded, striæ very fine, last whorls with two spiral, reddish bands .... *solitaria*

---

*Pilsbry. The Nautilus, Vol. IX, p. 110.
†Guide to Study of Helices, pp. 42, 48, 49.

b. Depressed, periphery slightly carinated, striæ rib-like, whorls marked by reddish flames placed longitudinally .... *alternata*

B. Shell small.

a. Aperture devoid of teeth, spire slightly convex .... *striatella*

b. Aperture with from one to three teeth, spire flat .... *lineata*

SUBGENUS **PATULA** Held, 1837.

"*Shell:* Rather large and solid, with convex spire and open umbilicus; whorls rounded or carinated at the periphery. Surface striate, ribbed-striate or spirally ribbed, obliquely flamed, unicolored or spirally banded; lip thin, simple."

"*Animal:* Having a large foot, its length greater than the diameter of the shell, the tail rounded; sole without any traces of longitudinal divisions; the foot margins having a wide border above, bounded by a distinct groove, the grooves meeting over the tail. Eye-peduncles long and slender, tentacles minute. Mantle edge thick. Genitalia system (Fig. 47) simple, lacking accessory organs. Penis receiving vas deferens and retractor muscle at its summit. Spermatheca bulbous, its duct very long. Ovisperm duct very much convoluted, the ovo-testis consisting of small groups of large club-shaped follicles. Eye-

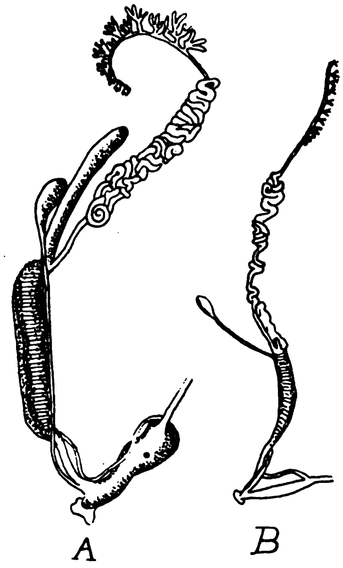

FIG. 47.

Genitalia of PYRAMIDULA. (Pilsbry, Guide to Helices, pl. xi, figs. 20, 21.) A, P. ALTERNATA Say. B, P. STRIATELLA Anthony.

peduncles retracted between the branches of the genitalia." (Pilsbry.)

For jaw and radula see the following species:

79. **Pyramidula alternata** Say, pl. xxviii, figs. 19, 21, 22 23, 24.

Helix alternata SAY, Nich. Encycl., pl. i, fig. 2, 1817-1819.
Helix scabra LAMARCK, An. sans. Vert., Vol. VI, pt. 2, p. 88.
Helix mordax SHULT, Bern. Mitt., p. 195, 1853. (Variety.)
Helix strongylodes PFEIFFER, Proc. Zool. Soc., p. 53, 1854.
Helix infecta PARREYSS, MS., Pfeiffer, Mal. Blätt., p. 86, 1857.
Helix dubia SHEPPARD, Trans. Lit. Hist. Soc. Quebec, Vol. I, p. 194.
Helix fergusoni BLAND, Ann. N. Y. Lyc., Vol. VII, p. 421, 1862. (Variety.)
Helix alternata var. *costata* LEWIS, Amer. Journ. Conch., Vol. VI, p. 188, 1871. (Variety.)
Helix alternata alba TRYON.
Pyramidula alternata carinata PILSBRY, Proc. Phil. Acad., p. 490, 1896. (Variety).
Pyramidula alternata rarinotata PILSBRY, The Nautilus, Vol. XIII, p. 114, 1900. (Variety.)
Pyramidula alternata knoxensis PILSBRY, The Nautilus, Vol. XV, p. 6, 1901. (Variety.)

Shell: Depressed, rather thin, widely umbilicated; surface dull, covered with strong, oblique, rib-like striæ; color yellowish horn with numerous reddish flames which extend obliquely from suture to suture, sometimes broken but generally entire; on the base of the shell the flames are interrupted so that a light yellowish or horn-colored band is formed, although in some specimens this is not developed; periphery slightly or heavily carinated; sutures very deeply impressed; apex of shell smooth; whorls five and one-half, gradually increasing, rather flat; spire elevated or depressed; aperture obliquely rounded, showing the color of the outer surface through the shell; peristome simple, sharp, terminations connected by a thin callus; columella subreflected; base rounded; umbilicus large, wide and deep, showing all the volutions to the apex.

Greater diam.,	22.00;	lesser,	19.50;	height,	15.00;	umbilicus diam.,	6.00 mill.
" "	21.00;	"	19.00;	"	14.00;	" "	6.00 "
" "	21.00;	"	18.00;	"	12.50;	" "	5.50 "
" "	20.00;	"	17.00;	"	12.00;	" "	5.00 "
" "	20.00;	"	16.50;	"	10.00;	" "	5.50 "

(All measurements from set 10142, showing variation in height of spire.)

Animal: With a long and narrow body; color of back, brown, of rest of upper surface brownish, with a tinge of orange, collar saffron-colored; eye-peduncles and head slaty, with the black eyes at the extremity of the former; tentacles short, cylindrical; foot grayish white in color, truncate before, bluntly rounded and flattened behind; a lateral groove runs from the head to the posterior part, just at the edge of the foot, and meets in an acute angle behind; respiratory orifice on right side, just beneath the peristome of the shell and near its junction with the body-whorl; mantle colored like shell. Length of foot 26.00 mill., width 6.00 mill.

The heart is situated 3 mill. from the junction of the peristome with the body wall, and the pulsations are very regular. Fifteen experiments gave the following number of pulsations per minute: 84, 82 (twelve specimens), 61, 50. The last two figures were taken when the animal was contracted, and the heart-beats much slower.

Jaw: Arched, broad, ends broadly rounded; concave margin not very much crenulated, with a rounded median projection; anterior surface marked by vertical striæ (Fig. 48, J).

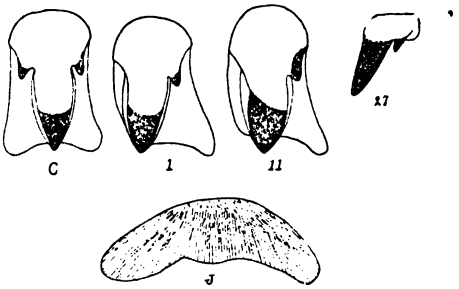

FIG. 48.

Radula of PYRAMIDULA ALTERNATA Say. (From nature, after Pilsbry, Guide to Helices, pl. xi, figs. 18, 23.) C, central tooth; 1, first lateral; 11, first marginal; 27, sixteenth marginal; J, jaw.

Radula formula: $\frac{24}{2}+\frac{10}{2}+\frac{1}{3}+\frac{10}{2}+\frac{24}{2}$ (34 – 1 – 34); central tooth with a subquadrate base of attachment, somewhat expanded on the lower outer corners; reflected portion with one long central cusp reaching below the lower edge of the base of attachment, and two very small side cusps with small cutting points; lateral teeth (ten perfect) longer than wide, bicuspid, the inner cusp long and narrow with a long, narrow cutting point, and the outer cusp short and wide with a short cutting point; marginals variable, at first like the laterals, but becoming wider toward the margin (twenty-seven) and with one long inner cusp and a short outer cusp. The cutting point is generally one-third the length of the cusp (Fig. 48). There are about 120 rows of teeth.

Genitalia: See generic description.

Distribution: Eastern and Central United States, and Canada; west to Minnesota.

Geological distribution: Pleistocene of the Mississippi Valley; Loess.

Habitat: Very abundant under logs, underbrush, and in crevices or under loose bark. Sometimes found buried in the earth. Dry situations are not favorable to it, and it prefers moist localities in wooded districts.

Remarks: This is our most abundant species, and, unlike most of our Helices, is gregarious, being generally found in colonies of from twenty to a hundred or more. The animal is sluggish in its movements, but is not at all shy, allowing itself to be picked up and examined without withdrawing into its shell. Its locomotion is slow and careful. The species is very variable in the height of its spire, some specimens having an elevated, convex spire, while others are perfectly flat. This variation is in a great measure due to the habit of crowding itself into narrow crevices, which causes the shell to assume a flat-whorled aspect. The convex forms are generally found in wide, open crevices or under logs, while the flat-whorled forms are found in small, narrow crevices or under loose bark. The albino form is found very sparingly. The measurements and figures show well the variation in the spire. The striation of the species varies from almost smooth (*fergusoni*) to very coarsely ribbed (*mordax*). It is fond of climbing trees and is often found at a considerable height from the ground.

Egg laying begins about the first week in June and the animals are then in their best condition. From twenty to eighty pure white, opaque eggs are laid, agglutinated together in soft clay (Fig. 22). About thirty days are required for them to hatch, and about the middle of July young snails are found with two perfect whorls. The eggs measure 2.75 mill. in diameter and when dry become hard and brittle.

80. **Pyramidula solitaria** Say, pl. xxix, fig. 1.

Helix solitaria SAY, Journ. Phil. Acad., Vol. II, p. 157, 1821.

Pyramidula occidentalis VON MARTENS.

Pyramidula solitaria limitaris DAWSON, L. and F. W. Moll. coll. Summers, 1873, 1874, pp. 347-350, 1875.

Patula solitaria albina W. G. BINNEY.

Shell: Depressed-globose, rather solid, diaphanous, deeply and widely umbilicated; surface slightly shining, covered with coarse, crowded, oblique striæ; color dark horn, with two revolving brownish bands, one just above and one just below the periphery, the latter being gracefully rounded and never carinate; sutures impressed; apex of shell smooth, without striæ, which begin to appear on the second whorl; whorls six, rounded, regularly increasing; spire elevated, convex; aperture rounded, somewhat lunate, white and pearly inside, with the two revolving bands showing distinctly; peristome sharp, simple, the terminations connected by a thin callus; columella somewhat dilated, subreflected; base rounded; umbilicus round, deep, showing the volutions very plainly to the apex.

Gr. diam., 26.00; lesser, 23.00; height, 20.00; umbilicus diam., 5.50 mill. (7716.)
" 26.00; " 22.00; " 19.00; " " 5.50 " (7718.)
" 23.00; " 21.00; " 15.50; " " 5.00 " (12393.)

Animal: Not examined (Fig. 49), but similar in form to *alternata.*

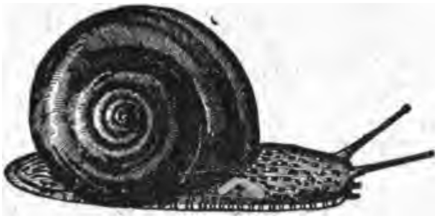

FIG. 49.
Animal of PYRAMIDULA SOLITARIA Say. (After Binney.)

Jaw: "Long, low, slightly arcuate, ends but little attenuated, anterior surface striate, but without ribs; a median projection to the cutting margin."

Radula: "The lingual membrane has 25–1–25 teeth, with 14 perfect laterals. The transition to marginals is very gradual." (Binney, Man., p. 255.) The teeth are similar to those of *alternata.*

Genitalia: "The penis sack is short, stout, receiving near its apex the retractor muscle, above which it rapidly decreases in size, and at its apex receives the vas deferens; the last named organ is very peculiar in being greatly convoluted before entering the penis sac; the genital bladder is small, globular, on a long duct, which becomes swollen at the lower end; the epididymis is convoluted in its entire course."*

Distribution: Mississippi and Ohio Valleys; Northern Idaho; Eastern Oregon, etc. (Pilsbry); Washington (Hemphill).

Geological distribution: Pleistocene; Loess.

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*Binney, Man. Amer. Land Shells, p. 255.

Habitat: The specimens in this region have been found in rather low, damp or marshy ground.

Remarks: This species is at once known by its semi-globose form and its two brown bands. It is a rare shell in this area and the writer has been unable to obtain living specimens for study. The only localities at present known are near Berry Lake, at Maywood and at Joliet. The species is said to have a strong fetid odor.

SUBGENUS **GONYODISCUS** Fitzinger, 1833.

"*Shell:* Rather small, depressed, with low but convex spire and open umbilicus. Apical 1½ whorls smooth, the rest obliquely rib-striate, rather tubular, rounded or keeled at the periphery, unicolored or flamed with reddish. Aperture wide-lunate, the lip simple."

"*Animal:* Long and narrow, the foot white, head and back dusky blue. Sole equal in length to the diameter of the shell, undivided (having a central longitudinal sulcus when entering the shell or in alcohol); margins of foot having a wide border, bounded by a distinct groove, the grooves meeting above the tail. Upper surface coarsely granulated. Eye-peduncles long and slender, from one-third to one-half as long as the foot. Genital system lacking all accessory organs. The penis short, having the retractor and the vas deferens inserted at its apex. Spermatheca small, situated upon a very long simple duct, which enters the vagina very low. At the base of the albumen gland there is a rather large talon. The albumen gland is small and adherent to the lower part of the hermaphrodite duct; the latter being large and very much convoluted." (Pilsbry.)*

For radula and jaw see following species.

81. Pyramidula striatella Anthony, pl. xxviii, fig. 18.

Helix striatella ANTHONY, Bost. Journ. Nat. Hist., Vol. III, p. 278, pl. iii, fig. 2, 1840.

Helix ruderata ADAMS, Silliman's Journ., 1st Ser., 40, 408, not STUDER.

Helix cronkhitei NEWCOMB, Proc. Cal. Acad. Nat. Sci., Vol. III, p. 180, 1865. (Variety.)

Pyramidula striatella catskillensis PILSBRY, The Nautilus, Vol. XI, p. 141, 1898. (Variety); Vol. XII, p. 86, 1898.

Pyramidula striatella alba WALKER, Terr. Moll., Mich., p. 22, 1899.

Shell: Flattened, thin, widely umbilicated; surface covered with crowded, oblique ribs, which are large and distinct, and are as much developed on the base as on the upper surface; color uniform dark horn, paler in some specimens; periphery rounded; sutures very deeply impressed; apex large, smooth, without striæ; whorls four, regularly increasing, the last inflated; spire a little elevated and convex; aperture nearly circular; peristome sharp, simple, the terminations approaching each other but not connected by a callus; columella rounded; umbilicus widely open, spreading, exhibiting all the volutions to the apex; base slightly rounded.

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*Guide to Study of Helices, p. 46.

Gr. diam., 5.75; lesser, 5.00; height, 2.50; umbilicus diam., 1.50 mill. (10229.)
" " 5.50; " 5.00; " 2.75; " " 2.00 " (10228.)
" " 5.00; " 4.50; " 2.50; " " 1.50 " (10227.)

Animal: With a rather short foot, truncated before and rounded behind, the margins having the same wide border and groove as in the other species of the genus; tentacles short, thick, blunt; eye-peduncles long, cylindrical, not much tapering, the eyes on large swellings at their tips; color blackish or dusky bluish above, dirty white beneath, including all of the foot. Heart situated as in *Zonitoides arboreus*, the pulsations regular, numbering eighty-seven to ninety beats per minute. Length of foot 5.00, width 1.00 mill. (Shell 5.75 mill. diameter.)

Jaw: Arched, with a small median projection; anterior surface striated; ends bluntly rounded.

Radula formula: $\frac{12}{2}+\frac{8}{2}+\frac{1}{3}+\frac{8}{2}+\frac{12}{2}$ (20—1—20); central tooth with a base of attachment a little longer than wide, not much expanded at the outer lower corners; reflection tricuspid, the central cusp long and narrow, the side cusps very short and thick; lateral teeth similar to central but bicuspid, the inner cusp long and narrow, reaching below the base of attachment and the outer cusp very short; marginals variable in form, all bicuspid, the inner cusp long and pointed and the outer cusp short, the base of attachment becoming very broad. All cusps have well-developed cutting points. There are about 100 rows of teeth.

The radula and jaw do not differ materially from those of *alternata* (Fig. 48), excepting that the bases of attachment are more square and not so much produced as in *alternata*.

Genitalia: See generic description.

Distribution: "Ontario to Winnipeg, Manitoba, Montana and Vancouver Islands, south to New Mexico and Arizona. Kern River Region, California. (Pilsbry.) Northern China, Kamchatka and Alaska. (Randolph.)

Geological distribution: Pleistocene; Loess.

Habitat: In moist localities, under fallen logs and sticks, or buried in the earth beneath them. Associated with *Vitrea electrina, Zonitoides arboreus,* etc.

Remarks: A very distinct little species which is at once distinguished by its strongly ribbed surface and very wide umbilicus. The animal is not rapid in movement but is slow and hesitating, seeming to calculate every motion. It is a widely distributed species, and is fully as common as the Vitreas. It is frequently mistaken for *P. perspectiva* Say, a species not found in this territory, which is a much larger shell.

GENUS **HELICODISCUS** Morse, 1864.

Mantle posterior, thin, simple; shell discoidal, widely umbilicated; aperture with several pairs of tubercles at intervals within, on the inner surface of the outer whorl; peristome simple.*

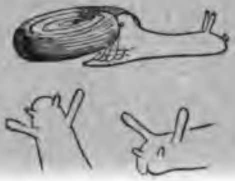

Fig. 50.
Animal of HELICODISCUS LINEATUS Say. (After Binney.)

82. **Helicodiscus lineatus** Say, pl. xxviii, fig. 25.

Helix lineata SAY, Journ. Phil. Acad., Vol. I, p. 18, 1817.
Planorbis parallelus SAY (?) Proc. Phil. Acad., Vol. II, p. 164, 1821.

Shell: Small, flat, discoidal, widely umbilicated; surface roughened by numerous equidistant, parallel, raised lines revolving about the whorls, the spaces between the lines showing fine, wavy lines of growth; color greenish horn; periphery broadly rounded; sutures deeply impressed or channeled; apex large, without revolving lines; whorls four and one-half, rounded, discoidal, the last not at all expanded; spire flat, showing all the whorls distinctly; aperture in the same plane as the whorls, narrow, semilunate, the outer lip bearing several (one to three) pairs of very small, conical teeth, and situated from the region of the peristome to the inner part of the last whorl; peristome simple, thin, acute, the terminations connected by a thin callus; umbilicus forming a concave depression, and exhibiting all the volutions almost as clearly as on the upper surface, and showing also very distinctly the oblique lines of growth.

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*W. G. Binney, Man. Amer. Land Shells, p. 74.

Gr. diam., 3.75; lesser, 3.50; height, 1.50; umbil. diam., 1.75 mill. (10929.)
" ", 4.00; " 3.75; " 1.50; " " 1.75 " (10126.)

Animal: With a long and narrow foot, deeply furrowed on the dorso-posterior portion; tentacles short and thick; eye-peduncles not long, thick and club-like; mantle thin, simple; color whitish, with pure white patches scattered about causing a mottled appearance. Shell placed well toward the posterior part of the body, and carried almost flat (Fig. 50).

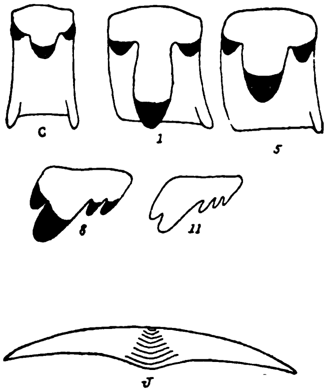

Fig. 51.

Radula of HELICODISCUS LINEATUS Say. (From nature, after Binney.) c, central tooth; 1, first lateral; 5, fifth lateral, modified; 8, 11, marginal teeth.

Jaw: Long and narrow, ends sharply attenuated; dorsal border rounded, smooth; ventral border with a large, rounded, median projection; anterior surface striate, the striæ converging toward the median projection (Fig. 51, J). Professor Pilsbry (Guide to Helices, Pl. xv, Fig. 1) figures a jaw with rounded ends and very arcuate. The specimens examined by myself seemed to be more like Morse's figure, although there was some variation.

Radula formula: $\frac{2}{4}+\frac{5}{3}+\frac{1}{3}+\frac{4}{3}+\frac{1}{3}+\frac{4}{3}+\frac{1}{3}+\frac{5}{3}+\frac{2}{4}$ (12 – 1 – 12); central tooth with a base of attachment longer than wide, the lower outer corners produced into small, narrow projections; reflection narrow, tricuspid, the central cusp longer than the two side cusps; lateral teeth with a wide base of attachment, almost square in fact, the lower right outer corner with a small, narrow projection; reflection tricuspid, the central cusp very long, rather wide, and reaching to the border of the base of attachment; side cusps short and wide; the fifth tooth is a modified lateral, with a much shortened central cusp; marginal teeth wider than long, reflection with three cusps, the inner cusp being longer than the outer and bifid; the outer cusps are small and narrow; the eleventh and twelfth marginals have three outer cusps instead of two; all the cusps have rounded, well developed cutting points (Fig. 51). There are over 75 rows of teeth.

Distribution: "Ontario and Quebec to Florida, west to Rio Chania and White Oaks, New Mexico (Pilsbry). Manitoba (Hanham).

Geological distribution: Pleistocene; Loess.

Habitat: In damp situations, under loose bark, in rotting wood, and under sticks, stones and leaves. Associated with *Pyramidula striatella*, *Zonitoides arboreus*, etc.

Remarks: A small species, at once distinguished by its flat whorls and armed aperture. The teeth within the aperture are placed as follows: one pair near the aperture; a second pair is placed within the aperture, a third or half a whorl from the opening, and a third pair (when present) still farther within the aperture. Each pair is placed one above the other, the superior tooth being at or a trifle above the periphery, and the inferior between that point and the base of the aperture. When the animal is in motion the shell is carried almost flat, the eye-peduncles and tentacles pointing upward at an angle of 85 degrees. The anterior part of the animal is much in advance of the shell, the latter being placed almost on the posterior extremity. This species is fully as abundant as the last, and is almost always found associated with it. It is one of the neatest of the smaller Helices.

Subfamily Punctinæ.

"*Jaw* composed of sixteen to twenty-four separate pieces." (Pilsbry.)

GENUS PUNCTUM Morse, 1864.

Shell: Small, discoidal, aperture subcircular, peristome thin. Jaw composed of numerous separate plates, which partly overlap each other. Radula with a unicuspid central tooth and bicuspid lateral teeth, all longer than wide. "Genital system lacking all accessory appendages." (Pilsbry.)

Distribution: "Holarctic realm." (Pilsbry.)

83. Punctum pygmæum Drap., pl. xxviii, fig. 20.

Helix pygmæum DRAP., Tab. Moll., p. 114, pl. viii, figs. 8-10, 1801.
Helix minutissima LEA, Trans. Amer. Phil. Soc., Vol. IX, p. 17; Proc., Vol. II, p. 82, 1841.

Shell: Subglobose, rather strong, umbilicated; surface dull or shining, marked by numerous strong, rounded, elevated striæ and very fine spiral lines, which are stronger on the base than elsewhere; color reddish or brownish; periphery rounded; sutures very deeply impressed, especially between the last two whorls; whorls four, convex, regularly and gradually increasing in size; spire elevated, convex; aperture somewhat oblique, crescentic, ample; peristome simple, rather solid; columella subreflected, the terminations of the aperture widely separated; umbilicus wide, deep, showing all the volutions to the apex.

Greater diameter, 1.00; height, 0.50 mill. (11457.)

Animal: Not observed.

Genitalia: Not observed.

Jaw: "Arcuate or horse-shoe shaped, composed of thirteen to nineteen separate rhomboidal plates, more or less overlapping, the outer imbricating over the inner plates; the median two or three plates slightly separated, not overlapping." (Pilsbry.)* (Fig. 52.)

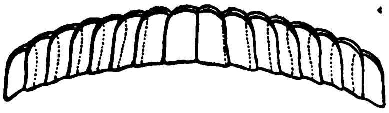

Fig. 52.
Jaw of PUNCTUM PYGMÆUM Drap. (After Binney.)

Radula formula: $\frac{13}{2}+\frac{1}{3}+\frac{13}{2}$ (13—1—13); central tooth with a long and narrow base of attachment, the lower outer corners somewhat expanded, but the lower edge straight or only slightly concave; reflection tricuspid, the central cusp short, wide, rather sharp, reaching about a third of the distance from upper to lower edge of basal plate, side cusps very short and wide, rounded; lateral teeth with a base of attachment almost as wide as long, squarely truncated at the lower edge; reflection large, bicuspid, the inner cusp wide and reaching more than half way to the lower margin of the base of attachment; outer cusp short, wide, widely separated from the inner cusp; the outer laterals and marginals are similar to the first lateral, excepting that the inner cusp first becomes longer, and then (on the extreme marginals) becomes equal in size with the outer cusp, and the base of attachment becomes short and wide. This description is from the form known as *minutissimum*, in which there are 54 rows of teeth. The typical *pygmæum* has 114 rows of 19-1-19 teeth (Fig. 53). All of the teeth are more or less separated.

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*Guide to Study of Helices, p. 7.

Distribution: Circumpolar. Northern United States and Southern Canada south to Texas and west to California.

Geological distribution: Pleistocene.

Habitat: Found rather plentifully under chips and pieces of wood on the edge of forests.

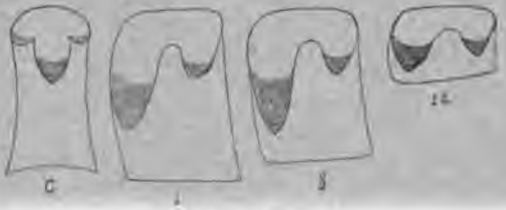

Fig. 53.
Radula of PUNCTUM PYGMÆUM Drap. (MINUTISSIMUM Lea.) c, central tooth; 1, first lateral; 8, transition tooth; 12, marginal tooth.

Remarks: This is one of our smallest shells, and is easily distinguished from all others by its subglobose form and discoidal whorls. Thus far it has only been collected in the northern and western regions, but it will probably be found, after careful search, in the southern region.

Heterurethra.

Superfamily Elasmognatha.

Jaw provided with a superior, quadrangular plate.

FAMILY SUCCINIDÆ.

Shell: Thin, transparent; aperture very large; spire very small and short.

Animal: Large, scarcely able to withdraw into its shell; foot very broad; eye-peduncles but little developed; tentacles very small; jaw provided with an accessory plate; lingual membrane with a high, narrow, central tooth, tricuspid; laterals of same size, bi- or tricuspid; margins with narrow bases, multicuspid.

GENUS **SUCCINEA** Draparnaud, 1801.

Shell: Very thin and fragile, imperforate, ovate; aperture very large, occupying the greater part of the shell; columella acute, simple; peristome straight, simple.

Animal: Elongated, truncated before, pointed behind; mantle protected by a shell, but not concealing the entire animal as in Helix; respiratory and anal orifices on right of mantle edge, just beneath the peristome; generative orifice behind right eye-peduncle; caudal mucus pore absent; locomotive disk (?) (Fig. 54).

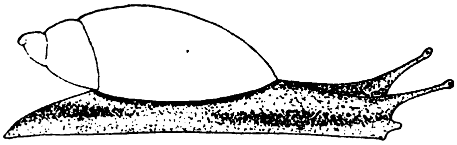

Fig. 54.
Animal of SUCCINEA OVALIS Say. (Original.)

Jaw: Arched, with large, quadrangular accessory plate; the ends (of jaw) acuminate or blunt; cutting edge with median projection, frequently broken by ends of ribs. Lingual membrane resembling that of *Patula.* The middle portion of the lower edge of the base of attachment of the central tooth is peculiarly cut away and thinned, as is also the inner lower lateral angle of the base of the laterals and marginals. The marginals are peculiarly constructed as regards the cusps, there being two small outer side cusps, each bearing cutting points; the reflection is quite small when compared to the size of the base of attachment.

Genitalia: Mr. W. G. Binney thus describes the genitalia (of *S. ovalis*): "The testicle is not separated into distinct fasciculi by the parenchyma of the liver, as in *Helix*, but forms a single mass; the epididymis is very much convoluted, and appears always to be distended with spermatic matter; the prostate gland is usually short, occupying the upper half only of the length of the oviduct, and is thick, clavate, and more or less covered by pigmentum nigrum cells upon the surface; the penis sac is long, cylindroid, curved downward at its upper part, and is joined at its summit by the vas deferens; the retractor muscle is inserted into the penis sac a short distance from its summit; the genital bladder is large and globular; its duct is nearly as long as the oviduct, and is narrow; the vagina is moderately long and muscular; the cloaca is short.[*]

Distribution: World-wide.

KEY TO SPECIES OF SUCCINEA.

A. Spire short, aperture occupying the greater part of the shell.
  a. Aperture wide, oblique.......................................*ovalis*
  b. Aperture long, narrow, straight..............................*retusa*
B. Spire long, aperture occupying a little over half of the shell....*avara*

84. Succinea ovalis Say, pl. xxx, figs. 22, 23.

Succinea ovalis Say, Journ. Phil. Acad., Vol. I, p. 15, 1817.

Succinea obliqua Say, Long's Expedition, Vol. II, p. 260, pl. xv, fig. 7, 1824.

Succinea totteniana Lea, Proc. Amer. Phil. Soc., Vol. II, p. 32, 1841. (Variety.)

Shell: Large (for the genus), thin, fragile, ovately-oblique, pellucid; surface shining, marked by distinct lines of growth, sometimes raised in ridges; color yellowish green or amber, sometimes very light, at others very dark; whorls three, rapidly enlarging, the last being more than twice the length of the others combined, very oblique and much expanded; spire short, blunt; sutures well impressed; aperture obliquely ovate, very large, occupying more than two-thirds of the entire shell; columella thin, narrow, its margin slightly glazed with testaceous matter; peristome thin, blunted, the terminations connected by a thin callus; the shell is covered with a very fine periostracum.

Length,	22.00;	diam.,	12.50;	aper.	length,	15.50;	diam.,	9.50	mill.	(10451.)
"	22.00;	"	13.00;	"	"	16.00;	"	9.75	"	(10451.)
"	20.00;	"	12.00;	"	"	14.00;	"	9.00	"	(10449.)
"	17.50;	"	11.00;	"	"	12.50;	"	9.00	"	(10442.)

Animal: With a wide foot, truncate before, rounded behind; color in general yellowish or saffron, with seven distinct black lines on the anterior part, one in the center of the head, one on the dorsal surface of each eye-peduncle, one on each side of the neck and one on each side of the foot; the mantle is grayish in color; tentacles white, small, inconspicuous; eye-peduncles rather short, thick, blunt, the eyes placed as usual at the tips; there is a deep furrow on each side, commencing at the anterior part of the mantle and extending downward and forward to a point behind the tentacles; sometimes the central stripe, which extends from the mouth over the head to the mantle, is quite large and composed of small black blotches. Length of foot 13.00, width 6.00 mill. Heart situated midway between the anterior and posterior borders of the aperture, to the left of the columella, pulsations regular, sixty-nine per minute.

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[*] Man. Amer. Land Shells, p. 343. The author is also indebted to Mr. Binney for much or most of the information used under the generic description of *Succinea*.

Jaw: With the usual quadrate, superior appendage common to the genus; cutting portion arched, with a median projection to cutting edge; anterior surface with from three to seven ribs which denticulate both margins (Fig. 55, J).

Radula formula: $\frac{32}{3}+\frac{10}{2}+\frac{1}{3}+\frac{10}{2}+\frac{32}{3}$ (42—1—42); central tooth with a subquadrate base of attachment, the lower outer corners expanded and the base concave; reflection tricuspid, the central cusp long and wide, nearly or quite reaching the lower margin of the base of attachment, the side cusps very short; lateral teeth similar to central, longer than wide, bicuspid, the inner cusp very long and wide, reaching below the lower margin of the base of attachment, the outer cusp very small; the third outer cusp on the first few laterals is rudimentary; marginal teeth modified laterals, wider than long, tricuspid, the inner cusp long and wide, acute, and the two outer cusps short, narrow and pointed. All of the cusps are provided with well marked cutting points (Fig. 55).

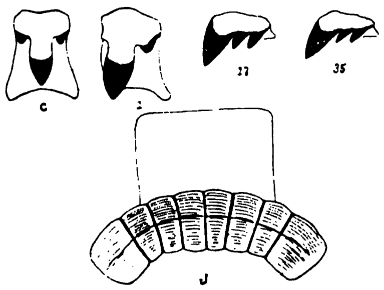

Fig. 55.

Radula of SUCCINEA OVALIS Say. (Original.) c, central tooth; 1, first lateral; 17, 35 marginal teeth; J, jaw.

Genitalia: See generic description.

Distribution: Eastern and Central parts of Northern United States, west to Manitoba, south to Arkansas and Georgia; Canada.

Geological distribution: Pleistocene; Loess.

Habitat: Found generally in moist localities, in the vicinity of some body of water, crawling on the grass and rushes along the margins. Also found on tree trunks to a considerable height, at some distance from water.

Remarks: This is a species at once distinguished by its large size and peculiar oblique aperture. It is a very common mollusk and is found almost everywhere. At Bowmanville it has been seen on the bark of elm trees over five feet from the ground, where there was little or no moisture. There is some variation in the obliquity of the aperture, some specimens having the aperture long, narrow and straight. There is a form found at Bowmanville which approaches var. *totteniana* Lea, (pl. xxx, fig. 23); it is smaller, of a greenish tinge, and the aperture is more oval and less oblique; the animal is much darker, when alive, than typical *ovalis*. The radula and jaw are similar to those of *ovalis*. During the summer the animal is not able to withdraw completely into its shell, but as soon as winter approaches, the animal becomes smaller and is found in hibernation, withdrawn so far within the shell that half of the last whorl is empty.

The species is universally distributed throughout the area.

Students of the Mollusca will no doubt be surprised that *ovalis* is used in place of *obliqua*. The writer believes, with Mr. Bryant Walker, that the elder Binney had no authority for using *obliqua* instead of *ovalis* when the latter species has seven years' priority. This being the case, the writer has used that name instead of *obliqua*.

85. Succinea retusa Lea, pl. xxx, fig. 24.

Succinea retusa LEA, Trans. Amer. Phil. Soc., Vol. V, p. 117, pl. xix, fig. 86, 1837.
Succinea ovalis GOULD, Invert. Mass., p. 194, fig. 125, 1841.
Succinea forsheyi LEA, Proc. Phil. Acad., p. 109, 1864, Obs., Vol. XI, p. 134, pl. xxiv, fig. 107.
Succinea wilsoni LEA, l. c., Obs. l. c., fig. 105.
Succinea decampi TRYON, Amer. Journ. Conch., Vol. II, p. 237, pl. ii, fig. 23, 1866. (Variety.)
Succinea calumetensis W. W. CALKINS, Valley Naturalist, Vol. 1, No. 2, p. 1, fig. St. Louis, Nov., 1878.
Succinea peoriensis WOLF, The Nautilus, Vol. VI, p. 19, 1892. (Variety.)

Shell: Very ovate, elongated, thin, pellucid; surface covered with very minute lines of growth; color very light horn or greenish-horn, sometimes tinged with rose; whorls three, very rapidly enlarging, not much expanded, the last whorl over twice the size of the others combined; spire very short, acute-conic; sutures very heavily impressed; aperture long-ovate, narrow, straight, wider below than above the center, where it rapidly narrows to an acute point; the aperture occupies from two-thirds to three-fourths the length of the entire shell and is somewhat patulous; when the shell is viewed from below, all the volutions may be seen within the aperture; peristome thin, simple, terminations widely separated; columella simple; a view from the side shows the shell to be more or less cone-shaped.

Length, 19.50; width, 9.00; aperture length, 14.00; wide, 7.00 mill. (6891.)
" 16.50; " 8.00; " " 12.00; " 6.50 " (9699.)
" 12.00; " 6.50; " " 8.50; " 5.00 " (10124.)

Animal: Generally whitish or amber colored, the upper part of the body covered with minute brownish or blackish dots arranged in clusters; there is a black line on the upper part, which extends from the ends of the eye-peduncles, along the sides of the neck to the shell; eye-peduncles short, thick, not much tapering, the eyes situated on bulb-shaped swellings at the tips; tentacles very short, conical; foot long and narrow, truncate before and pointed behind, 9.50 mill. long, and 2.00 mill. wide; the head is distinct and separated from the body by a neck; respiratory orifice on the right side of the shell near the peristome, about a fourth of the distance between the anterior and posterior borders of the latter. Heart situated to the left of the aperture, midway between upper and lower margins; pulsations somewhat irregular, one hundred and fifty to one hundred and fifty-five per minute.

Jaw: Arched, ends blunt; cutting edge with a central projection and three smaller swellings on each side; anterior surface smooth. The usual superior appendage is present. A specimen examined by Morse had the anterior surface cut up into several vertical furrows which modified the lower margin. Binney found a jaw with smooth anterior surface and strong median projection (Fig. 56, J).

Radula formula: $\frac{48}{5}+\frac{3}{3}+\frac{9}{2}+\frac{1}{3}+\frac{9}{2}+\frac{3}{3}+\frac{48}{5}$ (60—1—60); central tooth longer than wide, the lower part of the base of attachment produced at the outer corners, reflected portion tricuspid, the central cusp very long but not reaching the lower margin of the base of attachment, and the side cusps small; lateral teeth almost as wide as long, similar to central, bicuspid, the inner cusp very large, the outer cusp very small; there are 9 pure lateral teeth, followed by several modified laterals with two very small outer cusps; marginals wider than long, five-cuspid, the inner cusp small, the next large and the three outer cusps small; all of the teeth are provided with cutting points. The number of rows varies from 70 to 80 (Fig. 56). Mr. Binney found 60–1–60 teeth and Professor Morse 40–1–40. (Vide Amer. L. S., p. 389.)

Genitalia: Not examined.

Distribution: Northern and Middle United States and Southern Canada; west to Manitoba and south to Georgia.

Geological distribution: Pleistocene; Loess.

Habitat: Found about marshy regions, on the stems of water-plants and about wet stones and wood. Frequently found on the leaves of flags (*Iris*) and on lily pads (*Nymphæa*).

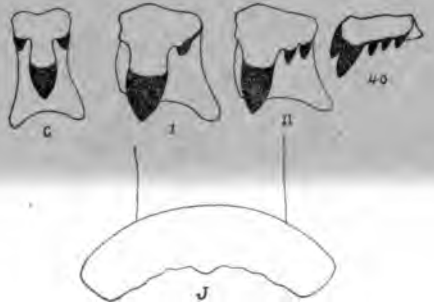

Fig. 56.
Radula of SUCCINEA RETUSA Lea. (Original.) c, central tooth; 1, first lateral, 11, intermediate lateral; 40, twenty-eighth marginal; J, jaw.

Remarks: A species easily distinguished by its narrow, conic shell and straight aperture. Mr. Binney says: "It deposits its eggs, to the number of about twenty, enveloped in a mass of thin, transparent gelatine, at the foot of aquatic plants. These gelatinous masses are very numerous . . . . . in the warm days of June. The eggs are oval and transparent." The writer has observed these egg-masses about the middle of June. This species, like others of the genus, is infested by a parasite (*Leucochloridum paradoxum*) which sometimes modifies the eye-peduncles. This parasite changes into *Distoma macrostomum* in birds. *Retusa* is universally distributed throughout the area.

85a. Succinea retusa magister Pilsbry.

Succinea retusa var. *magister* PILSBRY, The Nautilus, Vol. XI, p. 143, 1898.

Succinea retusa magister PILSBRY, The Nautilus, Vol. XII, p. 103, 1899.

Shell: Differing from *retusa* in being generally larger and in the less developed spire and larger aperture.

Length, 19.00; width, 9.50; aperture length, 14.00; width, 7.00 mill.

Animal: Similar to type.

Jaw and *Radula:* As in *retusa.*

Distribution: Northern Mississippi Valley.

Geological distribution: Pleistocene; Loess.

Habitat: Same as type.

Remarks: The variety does not seem to be as common as the type, although it is equally as widely distributed.

86. Succinea avara Say, pl. xxx, fig. 25.

Succinea avara SAY, Long's Exped., Vol. II, p. 260, pl. xv, fig. 6, 1822.

Succinea vermeta SAY, New Harm. Diss., Vol. II, p. 230, 1829. (Variety.

Succinea wardiana LEA, Proc. Amer. Phil. Soc., Vol. II, p. 31, 1841.

Succinea alba CKLL, The Nautilus, Vol. VII, p. 43, 1893. (Albino.)

Succinea compacta CKLL, l. c., p. 44, 1893.

Succinea major W. G. BINNEY, l. c., p. 44, 1893. (Variety.)

Shell: Elongate-ovate, thin and fragile, shining; surface covered with minute lines of growth with here and there a line raised into an elevated ridge, which are more pronounced on the last whorl; color straw to greenish-horn, sometimes rosy; whorls three, rapidly increasing, rounded, the last whorl a trifle more than half the length of the whole shell; spire rather long, acutely conic; sutures deeply impressed; aperture roundly ovate, last whorl not much expanded, straight or slightly oblique; peristome sharp, simple; columella simple, almost straight; when young, the shell is frequently slightly hirsute.

Length, 11.75; diam., 7.00; aperture length, 7.00; diam., 4.50 mill. (8462).)
" 11.00; " 6.00; " " 6.50; " 4.00 " (10439.)

Animal: Dirty white or yellowish-white in color, darker on head, neck and eye-peduncles; head distinct; eye-peduncles blunt, conical, of medium length, eyes black, situated as usual; foot long and narrow, somewhat flesh-colored, 8.00 mill. long and 1.50 mill. wide. In some specimens the body is almost transparent. The heart is situated one-sixteenth of an inch from the middle of the columella, to the left, and the pulsations number one hundred and thirty and are quite regular.

Jaw: Very strongly arched, the ends much attenuated and bent downwards; convex margin with two strong swellings situated centrally; concave margin with a strong median projection; anterior surface smooth (Fig. 57, J).

Radula formula: $\frac{8}{5}+\frac{5}{3}+\frac{8}{2}+\frac{1}{3}+\frac{8}{2}+\frac{5}{3}+\frac{8}{5}$ (21–1–21); central tooth as usual, the central cusp not being as long as in the other species mentioned; laterals eight in number, the outer side cusp being longer than usual; marginals similar to those of *retusa*, excepting that in the first five the inner cusp is not bifid and there are but two outer side cusps; all of the cusps are very long and bear sharp cutting points (Fig. 57).

Genitalia: Not examined.

Distribution: "Canada to Georgia, west to Minnesota, Montana, Utah, Texas and California." (Pilsbry.)

Geological distribution: Pleistocene; Loess.

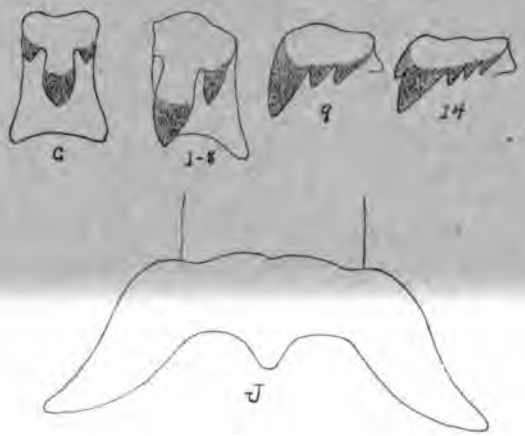

Fig. 57.

Radula of SUCCINEA AVARA Say. (Jaw after Binney, radula original.) c, central tooth; 1, 8, lateral teeth; 9, first intermediate marginal; 14 sixth marginal; J, jaw.

Habitat: Found plentifully under wet boards and logs and at the roots of vegetation situated in moist or wet localities. The vegetation beneath old wooden bridges is always a good locality for this species.

Remarks: *Avara* is distinguished from the previous species by its long spire and nearly round aperture The movements of this species are always slow and deliberate, and it lacks the energetic motions of its relatives, *ovalis* and *retusa*. The sutures are sometimes very deep and somewhat channeled. The species is not very common, except in a very few localities, but is found sparingly everywhere.

Orthurethra.

Ureter passing directly forward from the kidney toward the anterior of the lung. (Pilsbry.)

FAMILY PUPIDÆ.

Shell: Usually small, multispiral, generally elongated; aperture frequently contracted by internal teeth.

Animal: Tentacles small or wanting; foot very short, obtuse or pointed behind; jaw smooth or finely striated, frequently strengthened by the addition of a superior, arched plate, giving it the appearance of a double jaw; dentition resembling *Helix;* central and lateral teeth of same form and size (generally), tricuspid; marginals quadrate, low, wide, denticulated.

Genus **STROBILOPS** Pilsbry.

Strobilops Pilsbry, Proc. Phil. Acad., p. 403, 1892.

Strobila Morse, Journ. Portl. Soc., Vol. I, p. 26, figs. 64-67, pl. ii, fig. 12, a, b; pl. viii, fig. 68, 1864. (Non *Strobila* Sars, 1833; *Strobilus* Anton, 1839.)

Shell: Strongly striated, depressed-conic, umbilicated; aperture lunate; peristome reflected; parietal wall armed with several lamellæ which are provided with sharp, spiny projections at regular intervals.

Animal: Similar to that of *Pyramidula.*

Jaw: Long and narrow, arched, ribbed.

Radula: With numerous teeth similar to those of *Pupa.*

Distribution: North America and some of the West Indies.

87. **Strobilops labyrinthica** Say, pl. xxx, fig. 14.

Helix labyrinthica Say, Journ. Phil. Acad., Vol. I, p. 124, 1817.

Strobila morsei Dall, Proc. U. S. Nat. Mus., p. 263, 1885. (Variety.)

Strobila strebeli Pfeiffer, Malak. Blätt., Vol. VIII, pl. i, Figs. 5-8. Variety.)

Shell: Small, depressed-conic, umbilicated; surface covered with numerous heavy, oblique ribs, which are much finer on the base than on the upper surface; the apex is smooth; color brownish horn; whorls six, rounded, regularly increasing in size, the last somewhat globose; sutures well impressed; spire globose-conic or depressed; aperture lunate, a trifle oblique; on the parietal wall there are three revolving ribs, two of which nearly or quite reach the aperture while the third lies between these and is more deeply seated; these ribs are provided with swellings at regular intervals, which support a number of sharp spines pointing toward the aperture; on the columella there is also a smooth, heavy, revolving rib; on the base of the shell, placed far within the aperture, are two smooth, heavy lamellæ which extend only about a third of a volution; the parietal lamellæ are more or less granular in texture; peristome narrowly reflected, slighty thickened, the terminations widely separated; umbilicus narrow, open (Figs. 58, 59).

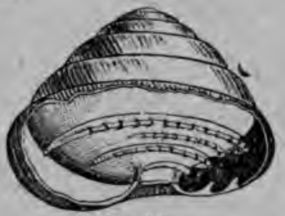

Fig. 58.

STROBILOPS LABYRINTHICA Say, showing parietal lamellæ. (Binney, Fig. 282.)

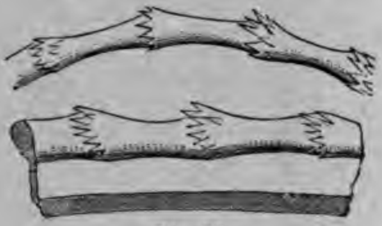

Fig. 59.

STROBILOPS LABYRINTHICA Say. Parietal lamellæ enlarged. (Binney, Fig. 283.)

Greater diameter, 2.15; lesser, 2.00; height, 1.50 mill. (11994.)
" " 2.15; " 2.00; " 1.60 " (11994.)

Animal: Very small; foot rather short, narrow, rounded before and behind; color white on the foot and sides of body and jet black on head, neck and eye-peduncles; the head is rather broad and the eye-peduncles are short, very thick and bulbous at their end, where the eyes are situated; the tentacles are very short and thick.

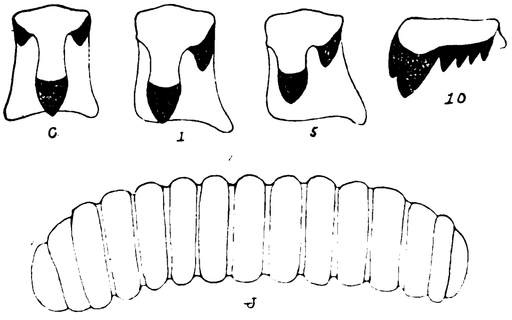

Fig. 60.

Radula of STROBILOPS LABYRINTHICA Say. (Original.) c, central tooth; 1, first lateral; 5, intermediate lateral; 10, fifth marginal; J, jaw.

Jaw: Long and narrow, somewhat arched, ends blunt;

surface with about thirteen heavy ribs, which denticulate both margins (Fig. 60, J).

Radula formula: $\frac{8}{3+5}+\frac{5}{2}+\frac{1}{3}+\frac{5}{2}+\frac{8}{3+5}$ (13—1—13); the central tooth has a rather wide base of attachment, attenuated at the lower outer corners and excavated on the lower border; the reflection is tricuspid, of which the center cusp is long and narrow, reaching to the lower edge of the base of attachment; the side cusps are very short. Lateral teeth similar to central tooth, but bicuspid, the inner cusp long and the outer cusp very short; the fifth lateral is modified by the shortening of the outer cusp. The marginal teeth are low and wide and denticulated by from three to five teeth, of which the inner is the largest and bifid. The cutting points of the central and lateral teeth are very short (Fig. 60). There are over 75 rows of teeth.

Genitalia: Unknown.

Distribution: United States and Canada, from Maine to Manitoba and south to Texas.

Geological distribution:. Pleistocene; Loess. Upper Eocene of Isle of Wight.

Habitat: Found on the edge of woodlands under and about pieces of wood and various kinds of débris.

Remarks: This is a most characteristic species, which cannot be mistaken for any other. The peculiar parietal ribs are different from any other species found in our region. The animal is very slow and deliberate in movement and the shell appears to be much too large for it. The latter is carried perfectly flat and the animal moves about in a wabbly manner. This species seems to be confined to the northern and western regions. It has been seen by Mr. Jensen to prey upon *Euconulus fulvus*.

KEY TO SPECIES OF PUPIDÆ.*

A. Aperture without teeth or folds............................*marginata*
B. Aperture with teeth or folds.
  a. Aperture squarish or rounded.
    1. Teeth few or wanting; never more than two, placed on the parietal wall...............................*corticaria*
    2. Teeth numerous (five to seven), parietal tooth bifid or bicuspidate; one or two basal teeth.
      †Teeth small, long, narrow, sharp, five in number, never filling the aperture; only one basal tooth....*procera*
      ††Teeth large, massive, almost or quite filling the aperture.

---

*Excepting *Strobilops*.

*Teeth five to seven, parietal tooth directed toward the *center of the outer lip;* base of shell *rounded* ....*armifera*

**Teeth three to four, parietal tooth directed toward the *base of the aperture;* base of shell keeled, an elevated callus connecting terminations of peristome..............................*contracta*

***Teeth generally six in number, parietal tooth directed toward the base of the aperture, bifurcated; no elevated callus connecting peristome terminations.................................*holzingeri*

3. Teeth numerous, but small, three basal teeth; parietal tooth simple.
   †Parietal tooth small, straight; eight teeth......*pentodon*
   ††Parietal tooth larger, curved; six teeth.......*curvidens*
4. Teeth generally small; a large, elevated, long, curved gular lamina on the base of the aperture; two small, pointed parietal teeth......................................*milium*

b. Aperture much wider than long, triangular, with a peculiar bulge at the upper, right hand corner; teeth five to seven, one to three parietal, two columellar, two basal, all small and very long...............................*ovata*

GENUS **PUPOIDES** Pfeiffer.

Shell: "Turriculate, aperture with a strong lip, without any lamellæ except a small, angular nodule." (Sterki.)

Animal: Blunt before and tapering behind; no caudal mucus pore or locomotive disk.

88. Pupoides marginatus Say, pl. xxx, fig. 9.
Cyclostoma marginata SAY, Journ. Phil. Acad., Vol. II, p. 172, 1821.
Pupa fallax SAY, of most American authors.
Pupa arizonensis GABB, Amer. Journ. Conch., Vol. II, p. 331, 1866.

Shell: More or less fusiform, smooth; surface covered with very fine, oblique lines of growth, the apex being smooth; color brownish-horn, lighter on the apex; whorls six, convex, regularly increasing in size from apex to base; sutures impressed; aperture oval or rounded; peristome reflected, whitish, the reflected portion lined with a thick callus; terminations curved, the right one very much so; no denticles within the aperture; umbilicus open, deep.

Length, 4.75; diameter, 2.00; aperture long, 1.30 mill. (10130.)
" 5.00; " 2.00; " " 1.30 " (12403.)

Animal: With the eye-peduncles, head, neck and fore part of the body black, the balance lighter; the animal is otherwise similar to the rest of the family. The foot is very long and narrow, almost, or quite, equaling the shell in length.

Jaw: Of the usual form, wide and slightly bent. The ends are blunt. Surface without ribs but vertically striated.

Radula formula: $\frac{8}{3-7}+\frac{7}{2}+\frac{1}{3}+\frac{7}{2}+\frac{8}{3-7}$ (15—1—15); some membranes seem to have the following formula: $\frac{8}{3-7}+\frac{6}{2}+\frac{1}{3}+\frac{6}{2}+\frac{8}{3-7}$ (14—1—14). The centrals are narrow, the laterals very wide, while the marginals are, as usual, low and wide with one large inner cusp, and several (2-6) small outer cusps, which are rather blunt.

Genitalia: Unknown.

Distribution: "Province of Ontario, Canada to Florida and west to Minnesota, Texas and Arizona." (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Found generally in open pastures or on the edge of woods, under stones, on blades of grass and about old wood. Seldom found in woods.

Remarks: A species at once distinguished by its turreted, fusiform shell and unarmed aperture. It is a rather common mollusk and is widely distributed in the northern and western regions.

GENUS **BIFIDARIA** Sterki.*

Bifidaria STERKI, The Nautilus, Vol. VII, p. 99, 1892.

"*Shell:* Cylindrical, turriculated, conical or oval; color varying from whitish to chestnut; surface smooth and polished or finely striate; sometimes lightly ribbed; aperture dentate, the parietal tooth being generally large and bifid or bifurcate; two (superior and inferior) palatal plicæ always present, generally deep-seated; a tooth is generally found at the base; additional denticles may sometimes be found, one on the parietal wall, between the parietal tooth and the columella, one above the upper palatal and one between the two palatals; columella somewhat complex." (Sterki.)

SECTION PRIVATULA Sterki.

"Shell cylindric; lamellæ few or none." (Sterki.)

89. **Bifidaria corticaria** Say, pl. xxx, fig. 10.

Odostomia corticaria SAY, Nich. Encycl., Vol. IV, pl. iv, fig. 5, 1817. First edition.

Pupa corticaria SAY, Nich. Encycl., Vol. IV, pl. iv, fig. 5, 1819. Third edition.

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*See The Nautilus, Vol. VI, p 2, 1892, for a list of the North American Pupidæ.

Shell: Cylindrical, shining, smooth; surface covered with fine, oblique growth lines, the apex being smooth; color whitish; whorls five to six, convex, the apical obtuse, regularly increasing in size; sutures well impressed; aperture subcircular, wide, two-thirds as high as the width of the last whorl; there are one or two small, white, pointed teeth on the parietal wall (sometimes altogether wanting), and the columella is provided with a small swelling or tuberosity; peristome reflected, white, terminations separated and joined by a thin callus; umbilicus narrowly perforated (Fig. 61).

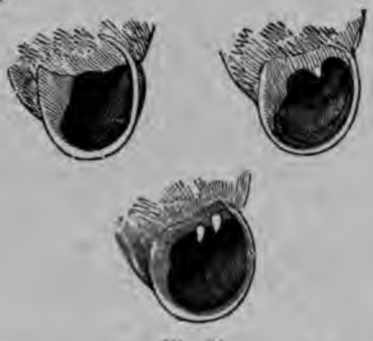

Fig 61.

BIFIDARIA CORTICARIA Say, showing variations of teeth. (Binney, Fig. 356.)

Length, 2.25; diameter, 1.00; aperture long, 0.75 mill. (10240.)

Animal: Of the usual form; color generally whitish, of a trifle darker color on the eye-peduncles and head. The foot is of unusual length.

Jaw: Considerably arched and tapering to a blunt point at either end; concave margin bearing a rounded median projection of considerable size. The anterior surface is longitudinally striated (Fig. 62).

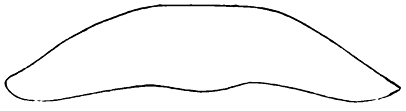

Fig. 62.

Jaw of BIFIDARIA CORTICARIA Say. (Original.)

Radula: As usual; formula $\frac{8}{3-7}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{8}{3-7}$ (12 — 1 — 12); three perfect laterals.

Genitalia: Unknown.

Distribution: "Ontario and Maine to Minnesota, south to South Carolina and Mississippi." (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Found rather sparingly in the crevices of rotting logs, under sticks, stones, etc., in damp places.

Remarks: *Corticaria* is distinguished by its obtuse apex and peculiarly armed aperture. The latter is very variable, being either simple or with one or two small conical teeth. The shell is peculiarly long and cylindrical, resembling somewhat *Cochlicopa lubrica* in general form. It is widely distributed.

SECTION BIFIDARIA Pilsbry (Sensu stricto) 1900.

(*Eubifidaria* Sterki, 1893.)

"Shell cylindric to turriculate; lamellæ typical." (Sterki.)

90. **Bifidaria procera** Gould, pl. xxx, fig. 11.

Pupa procera GOULD, Bost. Journ. Nat. Hist., Vol. III, p. 401, pl. iii, fig. 12, 1840.

Pupa carniata GOULD, *Olim*, an abnormal shell.

Pupa gibbosa SAY, Küster, and *P. minuta* SAY Pfr. (non Say).

Pupa rupicola SAY, Binney, Man. Amer. Land Sh., p. 328, fig. 354 (non Say).

Pupa pellucida PFR., Strebel, Beitr. Mex., Theil IV, p. 91, pl. iv, fig. 12; pl. xv, fig. 10.

Pupa hordeacea GABB, Binney, Man. Amer. Land Sh., p. 173, fig. 165.

Bifidaria procera cristata P. & V., Proc. Phil. Acad., p. 595, pl. xxii, figs. 4, 5, 1900. (Variety.)

Shell: Cylindrical, long, shining; surface covered with well-marked, oblique lines of growth, the apex smooth; color brownish or chestnut-horn; whorls six, convex, the last three about equal in size and the first three rapidly diminishing to the nucleus, making an obtuse apex; sutures deeply impressed; aperture ovate or semicircular, higher than wide; there are generally five teeth placed as follows: one on the parietal wall, large and somewhat compressed, long and bifid at the end; one on the columella, near the upper third, short, conical; a third on the upper third of the outer lip, thick, conical, short; a fourth on the base of the peristome, long, sharp; and a fifth placed behind the columella tooth, large and massive; peristome rather widely reflected, thickened, bluish-white; terminations approaching and joined by a callus; umbilicus small, open (Fig. 63).

Length, 2.50; diameter, 1.00; aperture length, 0.50 mill. (12321.)

Animal: Resembling that of *corticaria.*

Jaw: Rather wide, arcuated, ends slightly attenuated but blunt.

Radula formula: $\frac{6}{3-5}+\frac{5}{2}+\frac{1}{3}+\frac{5}{2}+\frac{6}{3-5}$ (11–1–11); teeth of the usual form.

Genitalia: Not known.

Distribution: Eastern United States west to Minnesota and south to Texas and South Carolina.

Geological Distribution: Pleistocene; Loess.

Habitat: Similar to *corticaria*.

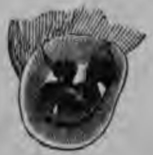

Fig. 63.
BIFIDARIA PROCERA Gould. (Binney, Fig. 354.)

Remarks: This species may be known by its peculiar aperture and five teeth. The parietal tooth is almost bifid and turns in toward the tooth on the columellar wall. *Procera* is very rare and has been found only in the southwestern part of the western region.

SECTION ALBINULA Sterki.

"Shell oblong or conic-ovate or cylindrical, colorless." (Sterki.)

91. **Bifidaria armifera** Say, pl. xxx, fig. 15.

Pupa armifera SAY, Journ. Phil. Acad., Vol. II, p. 162, 1821.

Pupa armigera POTIEZ et MICHAUD, Galérie, Vol. I, p. 159, pl. xvi, figs. 1, 2.

Bifidaria armifera ruidosensis CKLL., The Nautilus, Vol. XIII, p. 36, 1899.

Shell: More or less cylindrical, obtuse, inflated, transparent; color very light horn, vitreous; surface smooth and shining, lines of growth oblique, numerous, crowded; apex rounded, almost concealed by the succeeding whorls, light horn color; sutures well impressed; whorls six to seven, convex, the last three being about equal in size, and above these the shell tapers to an obtuse point; aperture ovate, narrowing toward the bend (throat) where there are from four to six teeth, arranged as follows: a single, sometimes bifid, lamelliform tooth which begins on the upper margin of the aperture, near the junction of the peristome with the upper margin; this tooth extends downward into the throat of the aperture; a second tooth, thick, rounded and massive, is situated far within the aperture, just where the throat turns into the body whorl and also where the umbilicus is placed; two teeth are placed on the peristome, one near the base and one on the right side; both are conical and tooth-like and are directed toward the center of the aperture; two other teeth are frequently developed, one conical but small near the junction of the peristome and body-whorl, and one rounded and massive situated on the base near the larger one before mentioned; peristome thin, terminations approaching, broadly reflected and connected by a thin callus; base of shell compressed to form a keel, which extends from the edge of the aperture to the umbilicus; umbilical region indented, opening small (Fig. 64).

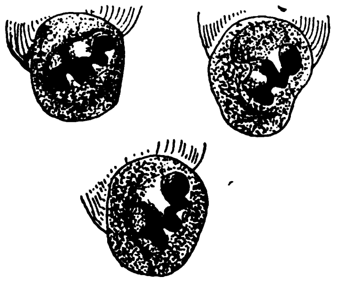

Fig. 64.

BIFIDARIA ARMIFERA Say, showing variations. (After Binney, Fig. 353.)

Length, 4.00; width, 2.25; aperture length, 1.60; width, 1.25 mill. (10238.)
" 4.50; " 2.25; " " 1.60; " 1.25 " (10238.)

Animal: Of the usual form; color whitish on foot; head, neck, and eye-peduncles black. The eye-peduncles are very long and tapering, and the whole animal is large and graceful. The foot measures 2 mill. in length and 1 mill in width, and is sometimes spotted with white.

Jaw: Not examined.

Radula formula: $\frac{7}{3-7}+\frac{7}{2}+\frac{1}{3}+\frac{7}{2}+\frac{7}{3-7}$ (14—1—14); teeth of the usual form; the central tooth is small, long and narrow, with a small tricuspid reflection; lateral teeth rather wide and bicuspid; marginal teeth as in the other members of the genus.

Genitalia: Unknown.

Distribution: Provinces of Ontario and Quebec, Canada, United States from Atlantic to Pacific.

Geological distribution: Pleistocene; Loess.

Habitat: Found in stations similar to the other Pupidæ.

Remarks: *Armifera* is one of our most characteristic species, distinguished by its cylindrical, swollen shell and large denticles in the aperture. It is the largest species of the genus (in this region) and is very common, being found in little colonies. Its habits resemble those of *contracta*. The animal is very slow and deliberate in movement and does not readily crawl about. It is found in the southern and western regions.

92. **Bifidaria contracta** Say, pl. xxx, fig. 8.

Pupa contracta SAY, Journ. Phil. Acad., Vol. II, p. 374, 1822.

Pupa deltostoma CHARPENTIER in CHEMNITZ, ed. 2, p. 181, pl. xxi, figs. 17-19.

Shell: Subconical, smooth, shining; growth lines very fine, oblique, apex smooth; color whitish; whorls five to six, convex, forming a pretty regular cone from the last whorl to the apex; the last whorl is a little ventricose, and is impressed behind the reflected peristome; apex obtuse; sutures deeply impressed; aperture somewhat triangular, narrow and long, expanded at the peristome and diminishing in size toward the throat, four-dentate, as follows: one large, entering tooth on the parietal wall, which is concave (bifid?) at its lower extremity, and almost fills up the aperture; a small, conical tooth placed near the peristome about midway between base and summit of aperture; two teeth, large and massive, placed deep in the throat, one, larger, situated near the umbilical region, and the other, smaller, placed near the parietal tooth; peristome widely reflected, somewhat thickened, white, made continuous by an elevated deposit of shell which connects the terminations; umbilicus small, open; the base of the shell has a sharp ridge or keel separating the umbilical region from the outer base of the shell (Fig. 65).

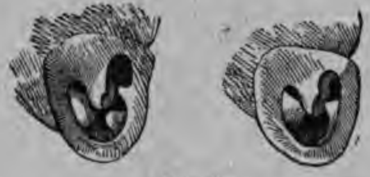

Fig. 65.

BIFIDARIA CONTRACTA Say. (Binney, Fig. 353½.)

Length, 2.50; diameter, 1.30; aperture long, 1.00 mill. (10239.)
" 3.00; " 1.50; " " 1.10 " (10646.)
" 2.50; " 1.25; " " .90 " (10237.)
" 2.75; " 1.50; " " 1.10 " (11995.)

Animal: Small, white and transparent, except head, neck and eye-peduncles which are black; foot narrow and long; eye-peduncles long and slender; tentacles conical, short. Respiratory orifice prominent, placed at the angle of peristome and body whorl.

Jaw: Long and narrow, slightly arched, the ends a little narrower than the central portion and rounded; convex margin smooth, concave margin notched, and anterior surface vertically striated (Fig. 66, J).

Radula formula: $\frac{7}{3-7}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{7}{3-7}$ (11—1—11); central tooth with a base of attachment longer than wide and with the lower outer angles expanded; reflection small, narrow, tricuspid, the central cusp long, wide, blunt, the side cusps shorter and sharper; lateral teeth with a wide base of attachment, expanded on the lower outer angle; reflection narrow, bicuspid, the inner cusp very long and wide, almost reaching the lower margin of the base of attachment, the outer cusp about half as large and sharp-pointed; marginal teeth low, wide, with from three to seven cusps, the single inner being very large and sharp, and the outer cusps short. The fifth marginal has three cusps, the seventh five cusps and the ninth seven cusps;

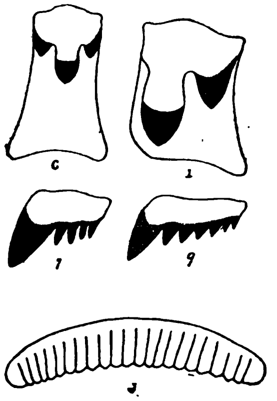

Fig. 66.

Radula of BIFIDARIA CONTRACTA Say. (Original.) c, central tooth; 1, first lateral; 7, third marginal; 9, fifth marginal; J, jaw.

all of the cusps have well developed cutting-points (Fig. 66).*

Genitalia: Not examined.

Distribution: Entire Northern United States, Ontario, Canada, and Eastern Mexico.

Geological distribution: Pleistocene.

Habitat: Found plentifully under chips and stones, in rotting logs, etc., on the edge of forests.

Remarks: Distinguished from *B. armifera* by its smaller size, triangular aperture, and especially the massive parietal tooth which nearly fills up the aperture. The keeled base is also a distinguishing feature. From *B. holzingeri* it is separated by its carinated base, fewer teeth in the aperture and their different form. It is a very abundant species and of much interest when studied alive. The shell is carried well upright and the motions of the animal are generally slow and methodical. Frequently when crawling over a table it will lift up its head and a portion of its body until only the tail rests on the surface. It is very widely distributed, being found in all the regions.

93. **Bifidaria holzingeri** Sterki. Text, fig. 67.

Pupa holzingeri STERKI, The Nautilus, Vol. III, p. 37, 1889.

Pupa holzingeri fordiana STERKI, The Nautilus, Vol. VI, p. 4, 1892.† (Variety).

Shell: Small, cylindrical, turreted, shining, minutely umbilicated; growth lines (striæ) minute, oblique; nucleus smooth; color whitish, vitreous; whorls five, convex, regularly increasing, the last two of about equal size and the first three forming a rather pointed apex; the last whorl is narrowed and descends slightly toward the aperture, and the base is considerably compressed but not keeled as in *contracta;* just back of the aperture there is an oblique, elevated ridge formed by a white callus, which follows the direction of the growth lines, and extends from the suture to the base; behind this ridge the body whorl is flattened and impressed by one of the teeth; sutures well impressed; aperture lateral, "inverted subovate, with a slight sinus at the upper part of the outer wall;" six-dentate as follows: one on the parietal wall, large, long, high, curved outward about the center, bifurcated, "the outer branch reaching the parietal wall;" one on the columella, high, longitudinal,

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*The descriptions of some of the radulæ here enumerated were first given in Journ. Cin. Soc., N. H., Vol. XIX, No. 3, pp. 81-89, 1897.

†This is the only reference the writer is able to find concerning this variety.

"its upper end turning in nearly a right angle toward the aperture, but not reaching the margin;" one on the base, small, conical; three on the outer lip, as follows: one just above the basal denticle, rather long, narrow, curved downwards; one in the middle of the outer lip, short, conical; and the third near the upper part of the lip, very small and conical; peristome reflected, the terminations joined by a very thin callus; umbilicus small, open* (Fig. 67).

Length, 1.75; diameter, 0.75; aperture length, 0.30 mill. (12322.)

Animal: Not seen.

Jaw: Not examined.

Radula: Not examined.

Genitalia: Unknown.

Distribution: Ohio to Manitoba, New Mexico, Kansas. (Sterki.) Put-in-Bay Island, Lake Erie. (Bryant Walker.)

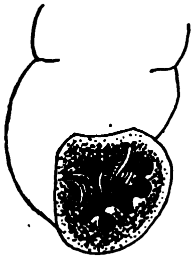

Fig. 67.

BIFIDARIA HOLZINGERI Sterki. (After Binney, Bull. Mus. Comp. Zool., Vol. XIX, No. 4, p. 194.)

Geological distribution: Pleistocene; Loess.

Habitat: Similar to that of *B. contracta.*

Remarks: This species is closely related to both *armifera* and *contracta.* Dr. Sterki says: "Our species ranges beside *B. armifera* and *B. contracta* Say, standing nearer the latter. Yet it is different from this species by the shape of the aperture, the wanting callous connecting the margins on the body whorl, by the longer crest behind the aperture, which in *contracta* disappears in about the middle of the (height of the) whorl, and by the wanting constriction, especially in the columellar wall, not to speak of the size and shape of the whole shell. The lamellæ also show some marked differences, such as the presence of a high basal, the shorter columella not reaching the base, but with relatively larger horizontal part, the bifurcation of the parietal and the presence of a supra-palatal" (on the upper part of the outer lip) "the last just as it is in *B. armifera.*" The species is very rare and is confined to the western region.

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*See Sterki, The Nautilus, l. c., and Binney, Third Supplement, Bull. Mus. Comp. Zool., Harv. Coll., Vol. XIX, No. 4, p. 193, to which the writer is indebted for much assistance.

SECTION VERTIGOPSIS (Cockerell) Sterki.

"Shell small, vertigo-like, albino; parietal lamellæ rather short and almost simple; palatals near the margin." (Sterki.)

94. **Bifidaria pentodon** Say, pl. xxx, fig. 12.

Pupa pentodon SAY, Journ. Phil. Acad., Vol. II, p. 476, 1822.

Pupa tappaniana ADAMS, Silliman's Journal, ed. i, Vol. XL, Suppl. Shells of Ver., p. 158, 1842.

Pupa pentodon curta STERKI, Land and F. W. Moll., New Phil., Ohio, 1894. (Variety.)

Pupa montanella CKLL., MSS., PILSBRY, The Nautilus, Vol. XI, p. 118, 1898.

Shell: Elongately ovate, shining, minutely umbilicated; growth lines minute, oblique; apex smooth; color spermaceti-white; whorls five, convex, regularly increasing in size, the last a little swollen and slightly impressed behind the peristome; apex obtusely pointed; sutures well impressed; aperture rounded or semicircular, scarcely oblique, eight-dentate as follows: a single, rather long, cylindrical tooth on the parietal wall, which is almost straight and directed toward the base; a small, conical tubercle on the columella; three small, conical tubercles on the base of the aperture, two small tubercles placed squarely on the base, and one, longer and narrow, placed on the turn of the outer lip; three small, conical tubercles on the outer lip (palatal), the upper and lower being very small and the central tubercle longer; one or more of these smaller tubercles may be wanting; all of the teeth are placed on a ridge of callus which encircles the inner surface of the aperture; peristome somewhat reflected, sharp, the terminations separated but connected by a thin callus; umbilicus very minutely perforated; base of shell rounded (Fig. 68).

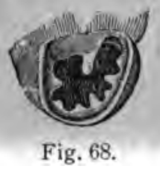

Fig. 68.
BIFIDARIA PENTODON Say. (Binney, Fig. 347.)

Length, 2.00; diameter, 1.15; aperture length, 0.85 mill. (11996.)

Animal: Of the usual form; color grayish white underneath and blackish above and on eye-peduncles. The foot is quite long and rather wide; eye-peduncles rather long and somewhat tapering; tentacles rather long, blunt, cylindrical.

Jaw: Similar to that of *V. milum*, slightly arcuate, width uniform, ends broadly rounded; concave margin notched and anterior surface striated longitudinally.

Radula formula: $\frac{6}{8-7}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{6}{8-7}$ (10—1—10); central tooth long and narrow, the tricuspid reflection very small; lateral teeth very wide, reinforced at the lower outer corner by a very small appendage to the base of attachment; marginals as in the other species. There are over 60 rows of teeth.

Genitalia: Unknown.

Distribution: "Ontario and Quebec, Canada, to Minnesota, south to Georgia and Texas; Lincoln Co., Nevada; Laggau, B. C." (Pilsbry.) Manitoba. (Hanham.)

Geological distribution: Pleistocene.

Habitat: Found about dead leaves under sticks, stones and rubbish, and about the foot of trees in low, moist localities.

Remarks: This species is distinguished from all our Pupæ by the small size and number of the teeth in the aperture, and also by the teeth being simple, especially the parietal tooth, which is small and narrow. It seems to be quite common and loves to congregate under leaves in little colonies. It is found in both the northern and western regions. One of the best times to collect this species is after a rain, when they will be found crawling over fallen trees, leaves and old débris.

95. **Bifidaria curvidens** Gould. Text figure 69.

Pupa curvidens GOULD, Journ. Phil. Acad., Vol. II, p. 476, 1822.

Pupa curvidens floridana DALL, Proc. U. S. Nat. Mus., p. 251, pl. xvii, fig. 11, 1885. (Variety.)

Pupa curvidens gracilis STERKI, L. and F. W. Moll., New Phil., Ohio, 1894. (Variety.)

Shell: In general form like that of *pentodon* but smaller; aperture more rounded than in *pentodon* and six-dentate, as follows: a single large, curved tooth on the parietal wall, which descends for a considerable distance into the aperture; a large columellar tooth, conical, placed about the middle of the columella; a third very small, conical tubercle placed at the left-hand turn of the peristome; a fourth, small, conical tubercle placed squarely on the base of the aperture; a fifth, larger, conical tubercle placed at the right-hand turn of the peristome and almost reaching the parietal tooth; and a sixth, small, conical tubercle placed at about the middle of the outer lip; the callus connecting the terminations of the peristome is narrower and more curved than in *pentodon;* other characters the same as in the other species (Fig. 69).

Length, 1.50; diameter, 0.90; aperture length, 0.50 mill. (10645.)
" 1.50; " 0.90; " " 0.40 " (11993.)

Animal: As in *pentodon.*

Jaw: Not differing from that of *pentodon.*

Radula: 10—1—10, in all respects like that of *pentodon.*

Genitalia: Unknown.

Distribution: Massachusetts to Minnesota; Ontario and Quebec, Canada, to Florida.

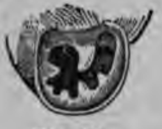

Fig. 69.
BIFIDARIA CURVIDENS Gould. (Binney, Fig. 347.)

Geological distribution: Pleistocene; Loess.

Habitat: In elevated localities, where moisture is reduced to a minimum.

Remarks: This species is distinguished from *B. pentodon* by its smaller size and peculiar apertural armature, the teeth being fewer in number, and the parietal tooth larger and curved inwards. It is always smaller, the whorls less rapidly increasing, and generally has a decided crest on the parietal wall. It is not as common as the last species, but is more widely distributed, being found in the three regions.

GENUS **VERTIGO** Draparnaud.

"*Animal* as in *Pupa*, but tentacles wanting."

"*Shell* deeply rimate, ovate, apex acuminate, obtuse; whorls 5-6, the last rounded; aperture semioval, with 4 to 7 folds; peristome scarcely expanded, white-lipped;"* Jaw arched, ends squarely truncated, anterior surface striate, cutting edge with median projection. Radula with a central tooth almost square, tricuspid, as large as or larger than the laterals, which are similar, narrower, and bi- or tricuspid; the marginals are low, wide and serrated.

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*Binney, Man. Amer. L. S., p. 333.

Distribution: Universal.

SUBGENUS **VERTILLA** Moq.—Tand. 1855.
(*Angustula* Sterki. 1889.)

[*] This group is "mainly characterized by the long and high gular lamina." (Sterki.)

96. **Vertigo milium** Gould, pl. xxx, fig. 16.

Pupa milium GOULD, Bost. Journ. Nat. Hist., Vol. III, p. 402, pl. iii, fig. 23, 1840.

Shell: Small, subcylindrical, smooth shining; growth lines very fine, a little oblique; nucleus smooth; color dark chestnut; whorls five, rounded, somewhat regularly increasing, decreasing to a bluntly rounded apex; sutures impressed; aperture obscurely semicircular, lateral, truncated above; the "circumference" of the aperture is "made up of two curves of different radius uniting in the peristome, where the junction causes an angle projecting inwards, the smaller curve comprising about one-fourth part and forming the superior portion of the peristome;"[†] aperture six-dentate as follows: two sharp, projecting teeth of about equal size placed on the parietal wall and dividing that region into three nearly equal parts; one on the columella, large, massive, broad; a third placed on the outer lip above or at the junction of the two radii, long, curved, ridge-like, pointing directly between the two parietal teeth; a fourth on the base of the lip, small, conical, tubercular; and one large, entering, elevated, long lamina, which begins on the base of the lip and curves backward until it disappears behind the columella tooth (this is the "gular lamina" of Sterki); peristome white or brownish-white, reflected, the terminations separated, but joined by a prominent callus; umbilicus well marked, open, deep; base of shell rounded (Fig. 70).

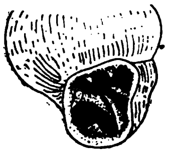

Fig. 70.
VERTIGO MILIUM Gould. (Original.)

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[*] Binney, Man. Amer. L. S., p. 332,

Length, 1.40; diameter, 0.90; aperture long, 0.30 mill. (11997.)
" 1.30; " 0.80; " " 0.25 " (11997.)

Animal: Similar in form to the other species of *Vertigo;* color dirty white, darker on the upper surface; foot very broad, posterior of the center, from whence it tapers rapidly to a point; the foot is thick and fleshy and well able to support the light shell; eye-peduncles of medium length, somewhat enlarged at the tips, where the eyes are placed.

Jaw: Very slightly arcuate, the ends a trifle rounded; concave margin notched and anterior surface lightly striated. The jaw is of equal width throughout its length (Fig. 71).

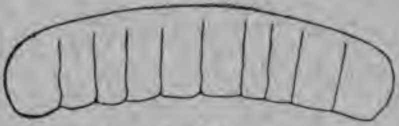

Fig. 71.
Jaw of VERTIGO MILIUM Gould. (Original.)

Radula formula: $\frac{7}{2-7}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{7}{2-7}$ (11 – 1 – 11); teeth as in the other members of the genus, and resembling closely those of *B. contracta* but somewhat wider. There are four perfect laterals and the first marginal similar but with a second outer cusp; from this point the marginals become wider, the inner cusp remains always the larger, and the outer cusp develops from five to seven small cusps or denticles.

Genitalia: Unknown.

Distribution: Maine to Minnesota, Ontario and Quebec, Canada, to Florida and Texas. (Pilsbry.)

Geological distribution: Pleistocene; Loess.

Habitat: Gregarious. Found plentifully under leaves, stones and sticks, in moist situations.

Remarks: This is the smallest of our Pupæ and is a very beautiful species, the peculiar gular lamina, dark chestnut color and globose-fusiform shape serving to distinguish it at a glance. There are sometimes several small accessory tubercles developed, but these do not affect its general specific character. It is confined, so far as known, to the northern and western regions.

SUBGENUS **VERTIGO** Drap. (Typical.)

97. **Vertigo ovata** Say, pl. xxx, fig. 13.
Vertigo ovata SAY, Journ. Phil. Acad., Vol. II, p. 375, 1822.
Pupa modesta SAY, Long's Exped., Vol. II, p. 25, pl. xv, fig. 5, 1824.
Pupa ovulum PFEIFFER, Olim. Symbolæ, Vol. I, p. 46.
Zonites upsoni CALKINS, Valley Nat., Vol. II, No. 4, p. 53, fig. 1880.

Shell: Small, ventricose, ovate, smooth and shining; growth lines fine, oblique; nucleus smooth; color light horn; whorls five, well rounded, the last inflated; apex obtusely pointed; sutures impressed; aperture semicircular, lateral, truncated above, the circumference made up as described under *V. milium*, six to nine dentate, as follows: One to three sharp, pointed teeth on the parietal wall, of which the central tooth, always the largest, is constant; one, constant, small, pointed, placed on the middle of the columella; one, constant, at the turn of the peristome, left corner, small, conical; two long, narrow teeth, constant, placed on the oblique base and outer lip; there is sometimes an eighth tubercle, small, conical, rather deep seated, placed between the two teeth on the base, and a ninth, very small tubercle placed above the highest tooth on the outer lip; peristome a trifle expanded, thin, grooved behind, the terminations widely separated and connected by a thin callus, whitish or brownish; umbilicus open, deep, somewhat expanded; the last whorl is peculiarly indented as it approaches the aperture (Fig. 72).

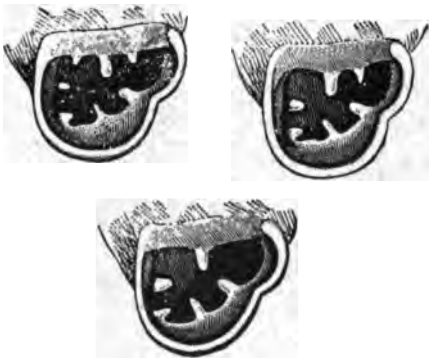

Fig. 72.
VERTIGO OVATA Say, showing variation. (Binney, Fig. 363.)

Length, 2.25; diameter, 1.50; aperture length, 0.50 mill. (12327.)

Animal: With a rather thick, short foot, trilobed in front and broadly rounded behind, the two antero-lateral lobes being very large and the central lobe small; eye-peduncles rather short, thick, club-shaped, swollen at their extremity, which bear the black eyes; color generally a cherry-red or blackish, fading into bluish or light blackish on the posterior end of the foot; the base of the foot is whitish; length of the foot 2.00 mill., width 1.00 mill.

Jaw: Very much arched, the ends square and the whole length very uniform in width; the concave portion bears a very well-developed median projection; the anterior surface is longitudinally striated (Fig. 73, J).

Radula formula: $\frac{5}{4-5}+\frac{3}{3}+\frac{6}{3}+\frac{1}{3}+\frac{6}{3}+\frac{3}{3}+\frac{5}{4-5}$ (14—1—14); central tooth with a base of attachment a little longer than wide; almost rectangular, with a broad reflection which bears the short cusps, rather stout, of which the center cusp is the longest; the lateral teeth (6) are similar but asymmetrical, tricuspid, the inner cusp being large and the two outer cusps small, the inner cusp reaching half way to the lower border of the base of attachment; the outer laterals (3) are somewhat modified, the inner cusp becoming shorter; the marginal teeth (5) are low and wide and serrated, the inner cusp being quite large and the outer cusps (3–5) being quite small. There are about 90 rows of teeth (Fig. 73).

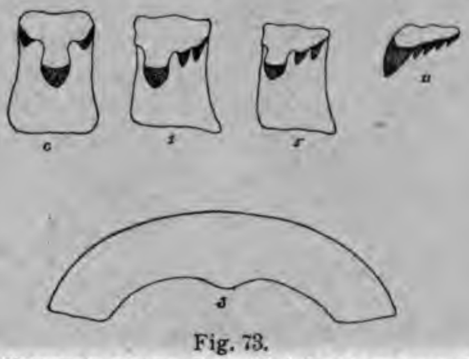

Fig. 73.

Radula of VERTIGO OVATA Say. (Original.) c, central tooth; 1, first lateral; 5, fifth lateral, modified; 11, typical marginal; J, jaw.

Genitalia: Unknown.

Distribution: North America and parts of Europe.

Geological distribution: Pleistocene.

Habitat: Found rather plentifully under sticks, stones, leaves, etc., in moist places, especially along the banks of rivers, ponds and creeks.

Remarks: This species is at once distinguished by its dentate aperture and the peculiar constriction of the last whorl. *Zonites upsoni* Calkins is probably nothing but the young of this species. Most, or all, of the Pupæ are very small when young.

It is quite common, but has thus far been found only in the western and northern regions. The animal is very sluggish in movement and does not move about like the Pupæ. It varies greatly in the number of teeth on the parietal wall, some having one, some two, and some three teeth, the percentage of each of these in a hundred being 3, 7 and 90. Specimens from Riverside have two teeth, the one placed in the center of the parietal wall being always the larger. When in progression the shell rolls from side to side in a very peculiar manner.

FAMILY COCHLICOPIDÆ.

Shell: Elongated, polished, white or horn-colored; spire turreted, aperture rounded, one-third to one-half the length of the shell; columella short, arcuate to subarcuate, truncated or scarcely so; peristome simple, straight, somewhat thickened within.

Animal: (See below under *Cochlicopa*); radula differing from Achatinidæ by the wide central tooth, which is narrow in the latter family.

Distribution: World wide.

GENUS **COCHLICOPA** (Fér.) Risso, 1826.

Shell: Elongated, imperforate, shining, smooth, pellucid; whorls rounded; aperture one-third the length of the shell; columella more or less truncated; margins of peristome joined by a callus.

Animal: Foot truncated before, roundly pointed behind; mantle thin; respiratory and anal orifices on right of body, just beneath the peristome of the shell; generative orifice behind the right eye-peduncle; no caudal mucus pore or locomotive disk.

Jaw: Long, low, wide, arcuate; ends blunt; cutting edge with a single large median projection; anterior surface not ribbed, but striate. Lingual membrane with central tooth long and narrow, tricuspid; laterals as wide as high, bi- or tricuspid; first marginals modified laterals; outer marginals wide, low, multicuspid. Genitalia with a short, stout penis sac "with the retractor muscle near its base; the vas deferens enters at its apex, and near its entrance into the vagina it receives a curious flagellate appendage, swollen below, narrow above, as long as the whole system, with a large, narrowly ovate bulb at its end;

the genital bladder is large, ovate, on a long, narrow duct." (W. G. Binney.)*

Distribution: North America, Europe, Madeira, Australia.

98. **Cochlicopa lubrica** Müller, pl. xxx, fig. 17.
Helix lubrica MÜLLER, Verm. Hist., Vol. I, p. 104, 1774.
Bulimus lubricoides STIMPSON, Shells of N. E., p. 54.
Cionella (Zua) morseana DOHERTY, Quart. Journ. Conch., Vol. I, p. 342, pl. iv, fig. 2, 1878. (Variety.)
Helix (Ferussacia) subcylindrica AUCT., non LINNÉ.
Ferussacia lubrica of various authors.

Shell: Small, elongate oval, pellucid, smooth, shining, transparent; surface covered with very fine growth lines, apex smooth; color smoky-horn; whorls six, convex, gradually and somewhat regularly increasing in size, each whorl being about twice the size of the one preceding, and the last being almost one-third the length of the entire shell; sutures impressed; spire conical, apex obtuse; aperture long-oval, the plane of the aperture parallel, or nearly so, with the axis of the shell; peristome simple, thickened, tinged with reddish; its terminations separated and connected by a thin callus; columella truncated at base, and somewhat sinuous at its junction with the peristome; umbilicus closed; base of shell rounded.

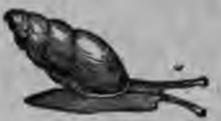

Fig. 74.
Animal of COCHLICOPA LUBRICA Müller. (Binney, Fig. 199.)

Length,	5.75;	diam.,	2.00;	aperture	length,	2.00;	diam.,	1.00	mill.	(10232.)
"	6.25;	"	2.25;	"	"	2.25;	"	1.25	"	(10131.)
"	6.00;	"	2.00;	"	"	2.25;	"	1.25	"	(10233.)

Animal: With a short, wide foot, truncate before and pointed behind; color bluish-black above, lighter below, especially on the foot; eye-peduncles long, thick, cylindrical, the eyes placed on prominences at their tips; tentacles very short, blunt; other characters as in the genus. Length of foot 6.00, width 2.00 mill. (Fig. 74).

Jaw: As described in the genus (Fig. 75, J).

Radula formula: $\frac{6}{6-8}+\frac{9}{2}+\frac{8}{2}+\frac{1}{3}+\frac{8}{2}+\frac{9}{2}+\frac{6}{6-8}$ (23—1—23): central tooth with a base of attachment much longer than wide, the lower margin concave and the outer corners expanded; reflection small, low, tricuspid, the center cusp reaching about half way to the margin of the base of attachment, the side cusps very small; lateral teeth almost as wide as long, bicuspid, the inner cusp long and wide, reaching below the base of attachment, the outer cusp short and blunt; marginal teeth at first a modification of the lateral teeth, the base of attachment being wider than high and the inner cusp gradually shortening; as the margin is reached the teeth become eight-cuspid (serrated) and are very wide and low (Fig. 75). The cusps are all provided with strong cutting points. There are about 90 rows of teeth.

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*Man. Amer. Land Shells, p. 195.

Genitalia: See generic description.

Distribution: North America, Europe and Asia; Point Barrow, Alaska. (Lehnert.)

Geological distribution: Pleistocene; Loess.

Habitat: Found plentifully under dead leaves and twigs, under decaying bark of fallen trees, in moss, etc., at the base of very old trees. It prefers the open forest.

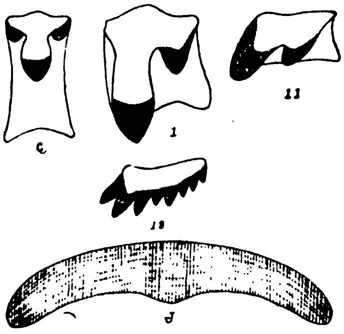

Fig. 75.

Radula of Cochlicopa lubrica Müller. (Original.) c, central tooth; 1, first lateral; 11, third marginal; 18, eighth marginal; J, jaw.

Remarks: A species at once known by its cylindrical, shining, glossy shell. The young shell of this species might easily be mistaken for a small *Helix;* it is short and stumpy and the thickened peristome, so characteristic of the adult, is not developed. In many forms the edge of the lip of the adult shell is colored reddish-brown, and there is a yellowish-white line or band around the penultimate whorl, where the liver shows through the shell. It is an interesting species in captivity, the animal being very bold and readily crawling over one's hand. In progression it is very rapid, probably exceeding, in comparison with its size, all other species in the rapidity with which it crawls. It seems to be confined to the northern and southern regions.

FAMILY VALLONIIDÆ.*

For general characters of the family, see the description of the genus Vallonia, below.

GENUS **VALLONIA** Risso, 1826.

Shell: "Minute, openly and widely umbilicate, depressed, the spire low-convex, consisting of 3 to 4½ whorls, color light and uniform; surface smooth or ribbed; periphery rounded; last whorl usually descending in front. Aperture oblique, circular or short-oval; peristome continuous or nearly so, expanded or reflexed, often thickened within." (Pilsbry.)

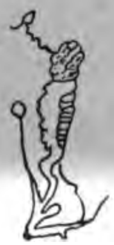

Fig. 76.

Genitalia of VALLONIA PULCHELLA Müller. (Pilsbry, Guide to Helices, pl. lxiii, Fig. 9.)

Animal: "Foot small, short, with no pedal grooves; edges of sole somewhat crenulated; sole undivided; eye-peduncles cylindrical, not enlarged distally; tentacles short; labial lobes well developed. Genitalia (Fig. 76) having the penis short, with terminal retractor; epiphallus short, bearing a flagellum. Dart sack present, single, containing a straight, bladeless dart. No mucus glands. Duct of spermatheca long, branchless." (Pilsbry). For jaw and radula see V. pulchella.

Distribution: "North America south to Texas; Japan and middle China to Europe and Atlantic Islands." (Pilsbry.) Found fossil in the Eocene and Miocene.

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*The position of this family, as well as that of Cochlicopidæ, is very uncertain, and it is placed here provisionally.

KEY TO SPECIES OF VALLONIA.

A. Shell with fine, oblique striæ.
  1. Lip reflected, shell light horn colored.................. *pulchella*

B. Shell coarsely costate.
  1. Color reddish horn, last whorl descending a little in front...*costata*
  2. Color reddish, smaller than 1; last whorl not descending...*parvula*

99. **Vallonia pulchella** Müller,* pl. xxviii, fig. 26.

Helix pulchella MÜLLER, Verm. Hist., Vol. II, p. 30, 1774.
Helix paludosa DA COSTA, 1780.
Helix crystallina DILLWYN, 1817.
Helix minuta SAY, Journ. Phil. Acad., p. 123, 1817.
Helix pulchella var. *lævigata* MOQUIN-TANDON, 1855, a. o.
Vallonia pulchella var. *enniensis* GREDL., Tirol's Conchylien, 1856.
Vallonia pulchella var. *persica* ROSEN., Nachrichtsbl, D. Mal. Ges., p. 123, 1892.
Vallonia pulchella var. *hispanica*, STERKI, Proc. Phil. Acad., p. 251, 1893.

Shell: Small, depressed conic, rather solid, umbilicated; surface shining, marked by numerous fine crowded oblique striæ, which are obsolete on the large, knob-shaped nuclear whorl; color light horn, opaque to transparent; periphery rounded; sutures deeply impressed or even excavated; whorls four, the last two rapidly increasing, rounded, the last whorl little, if any, descending at the aperture; spire plano-convex; aperture very nearly circular, a little oblique; peristome reflected, white, thickened, the ends approaching; umbilicus open, large, spreading, exhibiting all the volutions; base of shell convex.

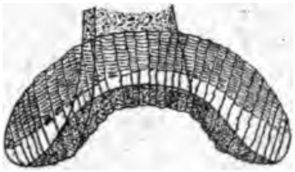

Fig. 77.

Jaw of VALLONIA PULCHELLA Müller. (Pilsbry, Guide to Helices, pl. 79, Fig. 29.)

Greater diam.,	2.50;	lesser,	2.00;	height,	1.25;	umbilicus,	0.80	mill.	(10125.)
" "	2.30;	"	1.90;	"	1.10;	"	0.80	"	(10125.)
" "	2.60;	"	2.10;	"	1.30;	"	0.80	"	(10125.)

Animal: With a small, short foot, marked on the sides and back by several fine longitudinal lines; tail with a mucus pore; eye-peduncles long and slender, tentacles short and blunt. The animal is colorless, translucent, so that the internal organs (jaw, etc.) may be seen through the body; heart beats irregular, ranging from twenty-five to one hundred (Sterki says 20 to 110) pulsations per minute. The heart is much affected by temperature and activity. For further notes see generic description.

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*See Sterki, Observations on Vallonia, Proceed. Phil. Acad., 1893, p. 246.

Jaw: Wider than high (about four to one); ends slightly angular; anterior surface marked by numerous (twenty-five) crowded ribs which denticulate the superior and inferior cutting edges; no median projection; a posterior accessory plate is present which extends from the inferior edge (Fig. 77).

Radula formula: $\frac{7}{4-5}+\frac{3}{3}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{3}{3}+\frac{7}{4-5}$ (13—1—13); central tooth with a base of attachment longer than wide, the lower border being somewhat expanded and produced into lower lateral projections; reflection short, tricuspid, the central cusp short, wide, the lateral cusps smaller; lateral teeth almost as wide as long, bicuspid, the inner cusp long and wide, the outer cusp quite small, with only an indication of a cutting point, which is well developed in the inner cusp; the base of attachment is provided with lower lateral appendages as in the central tooth; the fifth and sixth teeth are transition teeth, connecting the laterals with the marginals; these differ from the true laterals in having two small, narrow outer cusps (sometimes unicuspid), and the inner cusp is shorter; marginal teeth wider than long, four to five cuspid, the inner cusp generally larger, the outer cusp smaller and comb-like (Fig. 78). There are 65 to 70 rows of teeth.

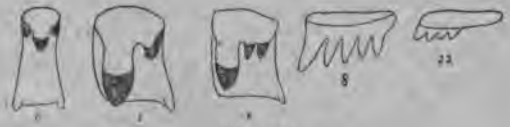

Fig. 78.

Radula of VALLONIA PULCHELLA Müller. (Original.) c, central tooth; 1, first lateral; 6, second transitional tooth; 8, second perfect marginal.

Genitalia: See generic description.

Distribution: Europe, Northern and Western Asia, Northern Africa, Azores, Madeira, North America, and Mauritius, Bermuda, New South Wales (introduced?). Not found on the Pacific coast of North America. (Sterki.)

Geological distribution: Pleistocene; Loess of North America, Europe and Asia.

Habitat: Found plentifully under wood, leaves, stones, old logs, in moss and on the banks of streams. Gregarious.

Remarks: This is our most common *Vallonia*, and cannot be confounded with any other in this region, where the shell always has a transparent or translucent horn color. The aperture and deflection of the last whorl varies to some extent, but with all this variation it is a species which will be at once recognized when seen. It is frequently found on flower-pots in Chicago residences, and is the most widely distributed species of the genus, being found in each of the three regions. It has been found in large numbers west of the poor farm at Dunning under board walks.

100. **Vallonia costata** Müller,

Helix costata MÜLLER. Verm. Hist., Vol. II, p. 31, 1774.
Vallonia rosalia, 1826 (ex. WESTERLUND, Fauna, Vol. I, p. 14).
Vallonia costata var. *helvetica* STERKI, Proc. Phil. Acad., p. 262, 1893.
Vallonia costata var. *amurensis* STERKI, l. c.
Vallonia costata var. *pyrenaica* STERKI, l. c.
Vallonia costata var. *montana* STERKI, l. c., p. 263.

Shell: Small, depressed convex, rather solid, umbilicated; surface shining, with regular membranous ribs of good size, the intercostate spaces being finely striate; color reddish-horn; periphery a trifle angled; sutures deeply impressed; whorls three and one-half, rapidly increasing, the last expanding and descending, somewhat angular on the periphery; spire flat, apex finely striate; aperture nearly circular, a little oblique, flattened above, angular below; peristome reflected, white, terminations approaching and connected by a thin callus; umbilicus open, large, spreading, exhibiting all the volutions.

Greater diameter, 2.70; lesser, 2.25; height, 1.30; umbilicus, 0.85 mill.

Animal: Similar to *pulchella*.

Jaw: Similar to that of *pulchella*, ribs sixteen to eighteen, ends of jaw smooth, cutting edge denticulated.

Radula formula: $\frac{8}{3-6}+\frac{1}{3}+\frac{4}{2}+\frac{1}{3}+\frac{4}{2}+\frac{1}{3}+\frac{8}{3-6}$ (13—1—13); central tooth as in *pulchella;* the side cusps very small; laterals with a long, thin inner cusp and a very small outer cusp, with cutting points as in *pulchella;* transition teeth (five) with the outer cusps split; the first marginals have but three cusps, but they soon assume the form of those in *pulchella*. There are about 70 rows of teeth.

Genitalia: As in *pulchella*.

Distribution: Europe, Northern Africa, Asia, North America, Australia. (Sterki.)

Geological distribution: Pleistocene; Loess.

Habitat: Same as *pulchella*.

Remarks: This species is distinguished from *pulchella* by its numerous heavy ribs and darker color. It does not seem to be a common species in this area and has thus far been found only in the northern and southern regions.

101. Vallonia parvula Sterki.

Vallonia parvula STERKI, Proc. Phil. Acad., p. 265, 1893.
Vallonia americana ANCEY, STERKI, Proc. Phil. Acad., p. 266, 1893.

Shell: "Small, widely umbilicated, especially for the last one-third to one-half whorl, quite flat above or with very little prominent apex, thin, horn-colored to nearly colorless, with fine, dense, membranous ribs (about thirty to thirty-eight on the last whorl), and microscopic, intercrossing lines between them; nucleus with fine revolving lines; whorls a little over three, slightly flattened above and below the periphery, with a deep suture; the last much wider than the penultimate, rather rapidly expanding toward the aperture and descending only at the suture in front; aperture very oblique, tangential and rather inclined, almost circular, with ends of margin much approximate; peristome with a rather strong, pale horn-colored lip. Diameter major, 2.00; min., 1.6; altitude about 0.8 m." (Sterki.)

Greater diameter, 2.00; lesser diameter, 1.40; height, 0.90 mill. (12318.)
" " 2.10; " " 1.60; " 1.00 " (12318.)

Animal: As in *costata*.

Jaw: With about eighteen ribs, otherwise as in *costata*.

Radula formula: $\frac{7}{4-5}+\frac{1}{3}+\frac{3}{2}+\frac{1}{3}+\frac{3}{2}+\frac{1}{3}+\frac{7}{4-5}$ (11—1—11); the teeth are all like those of *costata*, the same in the number of cusps on the marginals, and in the rapid transition from laterals to marginals.

Genitalia: Same as in *pulchella*.

Distribution: Illinois, Iowa, Nebraska, Kansas, Indian Territory. (Sterki.) Bay Island, Lake Erie. (Bryant Walker.)

Geological distribution: Pleistocene; Loess of Mississippi Valley.

Habitat: Same as *costata.*

Remarks: This species is very rare. It may be distinguished from *costata* by its smaller size, wider umbilicus, and by the last whorl being straight, while it is descending in *costata.* It is extremely local, and the only specimens found were from one locality on the Du Page Feeder. It is by some considered a synonym of *costata,* but seems to be sufficiently distinct.

SUBORDER BASOMMATOPHORA.

"Tentacles flattened-triangular or subcylindrical, contractile (but not invertible); eyes at their bases, sessile."

Shell usually covered by a corneous epidermis and oblong, few whorled, without operculum. Mostly aquatic or littoral."*

Superfamily Gehydrophila.

"Teguments rugose; terrestrial, but usually inhabiting seashores" (or bodies of fresh water).*

FAMILY AURICULIDÆ.

"*Shell* spiral, covered by an epidermis, solid, usually thick; spire more or less elevated; whorls sometimes flattened; aperture elongated, contracted by columella teeth, and often also by teeth within the lips."

"Lingual membrane broad and elongated; teeth numerous, in slightly bent cross-series; central tooth equilateral, narrow, tricuspid; lateral and marginal teeth also tricuspid, rather inequilateral, diminishing in size toward the outer edge. Head ending in a snout; mouth with a horny, lunate upper jaw, and with two dilated buccal lobes, united above, separate below; tentacles subcylindrical, contractile; eyes sessile at the inner sides of their bases. Mantle closed, with a thickened margin; respiratory orifice posterior, on the right side. Sexes united."*

Animal frequenting salt marshes or fresh bodies of water (inland).

GENUS **CARYCHIUM** Müller, 1774.

Shell: Thin, few whorled, pupiform; columella armed with a fold (sometimes absent); parietal wall armed with one or two denticles; peristome expanded, with a denticle on the inside.

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*Tryon, Syst. and Struct. Conch., Vol. III, p. 92.

Animal: (Fig. 79.) With a short, stout foot, which is divided into two portions, the anterior with the head and tentacles, and the posterior with the balance of the body; anterior portion bilobed and projecting, when the animal is in motion, in front of the head proper; body colorless; tentacles about a third the length of the foot, cylindrical, obtuse, with the eyes placed near the base of the tentacles, on the back. Genitalia? Jaw arched, with no ribs or denticulations. Radula with rows of teeth in a slightly bent series; the central tooth is narrow, equilateral and unicuspid, the laterals broad, short, and denticulated. Animal terrestrial.

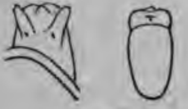

Fig. 79.

CARYCHIUM EXIGUUM Say. (Binney, Fig. 9.) Animal showing head and lower surface of foot.

Distribution: United States, Europe and Africa.

KEY TO SPECIES OF CARYCHIUM.

a. Shell cylindrical, aperture over one-third of total length, whorls four and one-half .... *exiguum*

b. Shell elongated, aperture one-third of the total length, whorls five and one-half .... *exile*

102. Carychium exiguum Say, pl. xxvi, Fig. 4.

Pupa exigua SAY, Journ. Phil. Acad., Vol. II, p. 375, 1822.

Carychium existelium BOURGUIGNAT, Mag. de Zoöl., p. 220, 1857.

Carychium euphæum BOURGUIGNAT, l. c., p. 221, 1857.

Carychium exiguum mexicanum PILSBRY, Proc. Phil. Acad., p. 319, pl. xiv, Figs. 7, 8, 9, 1891. (Variety.)

Shell: Cylindrical, pupiform, translucent, spire long and conic; color pearly white, surface shining, somewhat polished, lines of growth numerous, crowded, minute; whorls four and one-half, regularly increasing, convex, somewhat oblique in position; spire very long, conic, less than two-thirds the length of the entire shell; apex obtuse; sutures very deeply impressed, making quite a perceptible v-shaped depression between the whorls; base of shell rounded, exhibiting a round and deep umbilicus; aperture ovate, rounded below, narrowed at the upper part, more than one-third the total length; parietal wall with a large plait midway between the terminations of the peristome; there is a somewhat prominent callosity on the base of the aperture (or peristome) near the umbilicus; peristome thickened, flat, reflected, the terminations joined by a thin callus; outer lip sinuous, strongly arcuate at the upper portion; interior of aperture pearly-white.

Length, 1.50; width, 0.75; aperture length, 0.50; width, 0.30 mill. Berry Lake.

Animal: See generic description.

Jaw: Arched, dorsal and ventral margins smooth; anterior surface smooth or only slightly striated.

Radula formula: $\frac{1}{+}\frac{6}{6}+\frac{1}{1}+\frac{1}{6}\frac{6}{+}$; central tooth long and narrow, expanded considerably at the lower outer corners; reflection small, short, heart-shaped, blunt, unicuspid; lateral teeth a little longer than wide, reflection very low, serrated (Fig. 80). The writer was unable to make out clearly the character of the lateral teeth, but they appeared as indicated in the figure.

Genitalia: Not examined.

Distribution: United States west to Manitoba south to Mexico.

Geological distribution: Pleistocene; Loess.

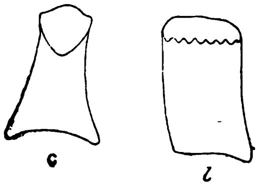

Fig. 80.

Radula of CARYCHIUM EXIGUUM Say. (Original.) c, central tooth; l, lateral tooth.

Habitat: Found plentifully under and about old logs, sticks, twigs and vegetation in the vicinity of ponds and creeks. Frequently found in wet moss.

Remarks: This is quite a peculiar little species, distinguished by its light color and peculiar shell. It loves company, and when one is found dozens are always sure to reward a patient search. The species is widely distributed in the area.

103. **Carychium exile** H. C. Lea, pl. xxvi, fig. 3.

Carychium exile H. C. LEA, Am. Journ. Sci., 1 series, Vol. XLII, p. 109, pl. i, fig. 5, 1841.

Carychium exile jamaicensis PILSBRY, Proc. Phil. Acad., p. 320, pl. xiv, figs. 15, 16, 1891. (Variety.)

Shell: Similar to *exiguum* but differing in the following particulars: the shell is elongated instead of cylindrical; there are five and one-half whorls; the aperture is *just* one-third the length of the shell, instead of *over* one-third, and the surface is "regularly and very distinctly striated."

Length, 1.75; width, 0.75; aperture length, 0.50; width, 0.25 mill. (12474.)

Animal: *Jaw* and *Dentition* apparently as in *C. exiguum.*

Genitalia: Not examined.

Distribution: Evidently the same as *exiguum.*

Geological distribution: Pleistocene; Loess.

Habitat: Same as and associated with *C. exiguum.*

Remarks: *Exile* is not as common as *exiguum*, the ratio being about 3 to 1 in favor of *exiguum*. The writer has always found the two species associated together (in Illinois). In view of this fact it may be possible that one is a variety of the other, instead of a distinct species, as the two forms may interbreed. This, however, is a subject for future study. Like *exiguum* the present species is widely distributed.

The genus *Carychium* is of great interest to the student of evolution, as it is more than probable that the Mollusca became terrestrial air-breathers through a form similar to *Carychium*, *Alexia* or *Melampus*. They are almost, but not quite, amphibious. *Carychium* is almost as frequently found in water as out of it, that is, under logs and stones in such moist localities that the animal is immersed in water. It has never been found, so far as known to the writer, in ponds or creeks, as is *Limnæa*.

Superfamily Hygrophila.*

"Teguments smooth; living in fresh water and only coming to the surface occasionally to renew their supply of air. Tentacles contractile, with eyes at their base. Jaw simple in *Physa* and compound in *Limnæa* and *Planorbis*, composed of three pieces corresponding to the three lips of the mouth, and not completely separated (Fig. 81). Central and lateral teeth as in Helicidæ, marginals pectinate or serriform."

"Male orifice near the tentacle, female at the base of the neck, near the respiratory opening. Eggs contained together in a gelatinous, transparent capsule. Phytophagous (*Physa* is sometimes carnivorous). Swimming in a reversed position at the surface of the water."†

---

*The writer is greatly indebted to Mr. Bryant Walker, of Detroit, Mich., for much assistance in preparing the account of the fresh water Pulmonates.

†Tryon, Struct. and Syst. Conch., Vol. III, p. 99.

FAMILY LIMNÆIDÆ.

Shell: Varying from long and pointed through oblong-ovate and obtuse to discoidal; whorls numerous, varying from planorboid to sharp pointed; aperture thin, lip simple, sharp.

Animal: With a wide foot, rounded behind; velar area preserved in the adult where they form two side lobes on the head; tentacles rather long, triangular or filiform; eyes placed on swellings at the inner bases of the tentacles; breathing orifice on right side. Mantle prominent. Buccal apparatus consisting of one median jaw and usually two or more lateral accessory jaws. Radula with either a very small, simple central tooth (*Limnæa*) or a larger bicuspid tooth (*Planorbis*), and numerous lateral and marginal teeth of variable form, being at first bi- or tricuspid, then tricuspid, and finally the reflection lengthens and narrows, and becomes four or five cuspid, the cusps being confined to the extreme distal part of the reflection, or serrating the outer edge (*Planorbis*).

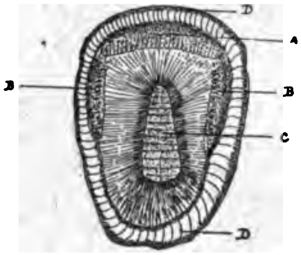

Fig. 81.

Mouth parts of LIMNÆA REFLEXA Say. (Original, from drowned specimen.) A, superior jaw; B, lateral jaws; C, radula; D, lips.

The genitalia may be thus described (for *L. emarginata* var. *mighelsi*):

Male organs: (Pl. xxxiii, Fig. E): As in the *Limnæidæ* generally, the male and female organs are separate (with the exception of the hermaphrodite gland) and open by separate orifices, that of the male being behind the right tentacle and that of the female at the base of the neck near the pulmonary opening. The penis sac (PS) is very large, of great length and large diameter; it is wide at the exterior opening but narrow at the end where the penis is attached. The penis (P) is half as long as the penis sac, very long and slender, with a rounded head, about two-and-a-half times the diameter of the neck of the penis. The penis and penis sac are retracted by a set of powerful muscles (RM, PSM, VD). A nerve starts from the cerebral ganglion (CG) and after extending for a short distance divides, one branch running to the head of the penis and the other entering the penis sac (PN, PSN). The penis is generally yellowish in color, sometimes very bright, while the penis sac is grayish (in alcohol) or yellowish (living). The muscles are white in color.

The vas deferens is long and hairlike (F), and extends from the head of the penis to the base of the penis sac where it becomes lost in the muscular tissue; it reappears at the opening of the vagina where it becomes the duct of the prostate (PD); this duct is rather long, very narrow and enlarges on the side of the vagina into the prostate gland (PR), a cylindrical, fleshy organ, well supplied with blood vessels and of a yellowish or amber color. Posterior to the cylindrical portion, the prostate becomes very much narrowed and flattened, whitish in color, and near the albuminiporous gland it again enlarges into a much folded organ of a grayish color. From this point the hermaphrodite duct passes to the hermaphrodite gland.

Female organs: (Pl. xxxiii, Fig. D): The hermaphrodite gland or ovotestis is made up of a number of rounded or lobulated follicles, which are yellowish in color. The oviduct (or hermaphrodite duct (OD) extends from the lower part of the ovotestis to the albuminiparous gland, from which it divides, one part forming the prostate and the other the uterus. The albuminiparous gland (AL) is large and rounded and of a greenish color. The uterus (U) is at first trilobed, then becomes smaller and rounded, then swells into a large, fleshy, cylindrical sack, the vagina (V), then contracts to form the vestibule or atrium (A) and finds its exit behind the male orifice and near the respiratory orifice. The uterus and vagina are yellowish in color. The walls of these organs are made up of strong muscular tissue. The spermatheca or receptaculum seminis (S) is elongate-oval in form, of a pearly white color, and connected with the vagina by a long, narrow duct (SD) which enters the latter near the cylindrical portion of the prostate, just above the atrium. The vagina is supplied with two stout retractor muscles (VM). In the natural position the ovotestis is folded in the lobes of the liver and is very strongly attached to that organ.*

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*For an extended account of the anatomy of Limnæa see the writer's paper, Bull. Chi. Acad. Sci., Vol. II, No. 3, from which the above description was mainly drawn.

Subfamily Limnæinæ.

"Lateral jaws present. Rhachidian tooth simply pointed; laterals provided with numerous denticles. Tentacles flattened. Genitalia on right side." (Dall.)†

GENUS LIMNÆA Lamarck.

Shell: Spiral, generally thin, corneous, ovately-oblong or elongate; spire long, sharp; aperture oval, generally small; columella with an oblique plait across the middle.

Animal: With short, wide, rounded foot; head supporting a vela area; front edge of mantle much thickened, simple, not projecting beyond the plane of the aperture; tentacles much flattened, triangular, the eyes sessile upon the inner bases; other characters as in the subfamily (Pl. xxxiii, Figs. A, B, C); ova deposited in a jelly-like mass without apparent envelope.

Distribution: World-wide, but preferring temperate regions.

KEY TO SPECIES OF LIMNÆA.*

A. Shell 50 to 60 mill. in length.
  a. Aperture and spire about equal in length, the former much expanded .... *stagnalis*
B. Shell 20 to 40 mill. in length.
  a. Spire attenuated, longer than aperture, the latter strongly reflexed; surface very rarely malleated .... *reflexa*
  b. Spire and aperture about equal in length; surface nearly always heavily malleated; shell wider in proportion to length than (a) .... *palustris*
C. Shell 15 mill. or less in length.
  1. Surface distinctly striated, with coarse, raised, spiral lines .... *caperata*
  2. Surface with fine, impressed spiral lines.
    a. Spire equal to aperture, shell fusiform .... *catascopium*
    c. Spire one-third to one-half the length of the aperture.
      †Spire sharply conic, aperture two-thirds of length .... *columella*
      ††Spire depressed conic, aperture three-fourths of length .... *woodruffi*
    d. Spire two-thirds the length of the shell, which is scalariform .... *ferrissi*
  3. Surface without spiral lines.
    a. Spire short conic, aperture roundly ovate, not produced at the lower part .... *humilis*
    b. Spire long and pointed, aperture long-ovate, produced at the lower part .... *desidiosa*

---

†Ann. and Lyc. Nat. Hist., Vol. IX, p. 348, et sec. All quotations of Dr. Dall are from this work.

*The account of the genus Limnæa is a modification of the author's paper in Trans Acad. Sci., St. Louis, Vol. IX, No. 1, 1901.

A recent study of numerous species of this genus has convinced the writer that some classification other than the one in use must be found. The present grouping by shell characters is totally unsatisfactory on account of the extreme variability of the individuals. For example, different forms of *L. emarginata* Say var. *mighelsi* Binney, recently examined, can be placed in all of the so-called subgenera usually recognized (*Radix*, *Bulimnea*, *Limnophysa*, etc.), and in fact the typical *emarginata* is typical of Limnophysa, and the variety *mighelsi* of Radix; all of the intermediate forms occur and absolutely connect the extremes. In view of this fact the writer has discarded all subgenera, using simply the generic term Limnæa. Some divisions of value will undoubtedly be found when all of the species are examined anatomically for the genitalia, radula, etc. There is abundant work in this line for a naturalist having the time and material at his command.

104. **Limnæa columella** Say, pl. xxx, fig. 26.

Limnæa columella SAY. Journ. Phil. Acad., Vol. I, p. 14, 1817.
Limnæa navicula VALENCIENNES, Rec'd. Obs., Vol. II, p. 251, 1833.
Limnæa chalybea GOULD, Am. Journ. Sci., ed. 1, Vol. XXXVIII, p. 196, 1840. (Variety.)
Limnæa acuminata ADAMS, l. c., Vol. XXXIX, p. 374, 1840.
Limnæa strigosa LEA, Proc. Amer. Phil. Soc., Vol. II, p. 33, 1841.
Limnæa coarctata LEA, l. c., p. 33, 1841.
Limnæa casta LEA, l. c., p. 33, 1841. (Variety.)
Succinea pellucida LEA, Proc. Phil. Acad., p. 109, 1864.
Limnæa columellaris ADAMS, Amer. Journ. Sci., ser. 1, Vol. XXXVI, p. 392, absq. descr.
Limnæa succiniformis ADAMS, MS., teste Haldeman.

Shell: Ovate, somewhat pointed, thin, fragile, transparent; color light greenish or yellowish horn; surface shining, covered with rather coarse growth lines, and encircled by impressed spiral lines; whorls four, rounded, rapidly enlarging, the last one three times the size of the rest of the shell; spires sharply conic, rather short; apex small, very dark brown; sutures impressed; aperture ovate, dilated, expanded at the lower part; the aperture varies from long and narrow to wide and somewhat expanded; peristome thin, acute; columella narrow, twisted; terminations of peristome connected by a thin callus; umbilicus generally closed but sometimes very narrowly perforate where the callus is not fully developed; the columella is so narrow that a view may be taken from the base nearly to the apex, as in *Succinea retusa*.

Length, 16.00; width, 8.50; aperture length, 11.40; width, 6.00 mill. (10440.)
" 14.00; " 7.75; " " 9.50; " 5.60 " (10440.)

Animal: Almost transparent, with a short, wide foot, bluntly rounded behind; head separated from foot by a constriction, wide, bifurcated; tentacles short, thick, triangular, transparent; eyes black, situated on small prominences at the inner base of the tentacles; color dirty white, darker on the body which is covered with white spots, seen through the transparent shell; edge of mantle transparent, simple; head above lilac-tinted; respiratory orifice on right side of body, near the junction of the upper part of the columella with the body whorl; the head is not much in advance of the edge of the shell when the animal is in motion; the animal appears much too large for the shell. Length of foot 8.00; width 5.50 mill. The heart is situated on the left side of the animal, as in *desidiosa.* The pulsations are rather irregular, three or four being quick, followed by a pause; they vary from fifty-three to sixty per minute.

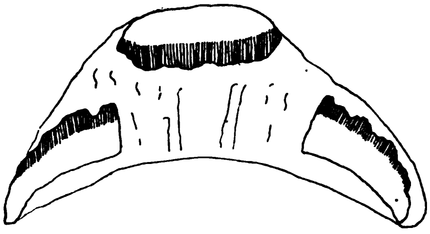

FIG. 82.
Jaws of LIMNÆA COLUMELLA Say. (Original.)

Jaw: Three, the median elliptical, smooth, the lateral jaws irregular; finely striated; cutting edges brownish black, shading into yellowish brown as the base of the cartilege is reached (Fig. 82).

Radula formula: $\frac{25}{4}+\frac{1}{3}+\frac{9}{2}+\frac{1}{1}+\frac{9}{2}+\frac{1}{3}+\frac{25}{4}$ (35 — 1 — 35); central tooth as in the genus; lateral teeth with a quadrate base of attachment; reflection long and rather wide, reaching below the base of attachment, bicuspid, the inner cusp very large and long, the outer cusp small and sharp; the tenth tooth is trifid and connects the lateral and marginal teeth; marginal teeth much longer than wide, generally four-cuspid, the outer cusp placed about midway of the reflection; the other three placed at the distal end; there are generally several small denticles on the upper outer edge of the reflection; the outer marginals have all the cusps placed at the distal end and the margins are simple (Fig. 83).

Genitalia: Not examined.

Distribution: New England to Iowa, Canada to Georgia; Tepic, New Mexico.*

Geological distribution: Pleistocene; Loess.

Habitat: Found abundantly in small ponds and creeks where the water is more or less stagnant. Particularly fond of a locality where lily pads are in abundance.

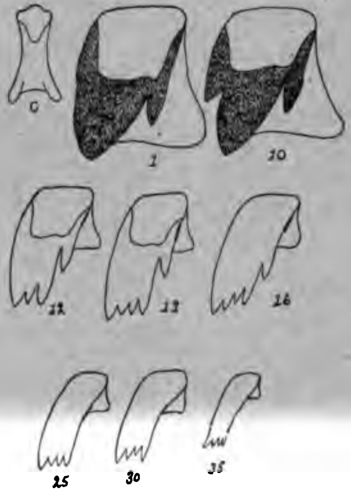

FIG. 83.

Radula of LIMNÆA COLUMELLA Say. (Original.) c, central tooth; 1, first lateral; 10, first marginal; 12, 13, 16, typical marginals; 25, 30, 35, outer marginals.

Remarks: This species is very variable in the shape of its aperture, and several distinct species have been made from these variations, which will stand simply as varieties. It is very frequently taken for a *Succinea*, and the shell bears a very strong resemblance to that genus. The animal, however, is quite different, and shows that it is a genuine *Limnæa*. The raised spiral lines are very beautiful and resemble those found on many land shells. So far as known it has only been collected in the greenhouses and lily ponds in Lincoln Park.

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*Vide J. G. Cooper, Proc. Cal. Acad. Sci., 2nd Ser., Vol. V, pt. 1, p. 167, 1895.

105. **Limnæa catascopium** Say, pl. xxxi, fig. 5.

Limnæa catascopium SAY, Nich. Encycl., ed. 1, pl. ii, fig. 3, 1816.

Limnæa cornea VALENCIENNES, Recueil d'Observ. Zool., etc., Vol. II, p. 251, 1833.

Limnæa sericata ZIEGLER, Rossmässler Iconog., Vol. I, p. 98, 1737.

Limnæa intertexta CURRIER, MSS., vide Bryant Walker, in letter.

Shell: Rather solid, ovate, inflated; color light horn to blackish; surface dull to shining, lines of growth numerous, fine, crowded, wavy, crossed by numerous impressed spiral lines; apex small, rounded, chestnut colored; whorls five, rounded, subinflated, the last large and somewhat inflated; spire sharp to obtuse, conic; sutures impressed; aperture roundly ovate, large, from half to three-fourths the length of the entire shell, rounded below; somewhat narrowed above; peristome thin, sharp, thickened by a light, whitish callus just within the edge; columella oblique, with a heavy plait across the middle; the lower part of the columella has a flexure caused by the heavy plait; the lower part of the peristome and the whole of the columella is sometimes covered by a heavy coating of white, testaceous material, which is reflected over the umbilicus, completely closing it.

Length, 15.00; width, 7.50; aperture length, 8.00; width, 4.50 mill.
" 13.00; " 7.00; " " 7.50; " 4.00 "
" 15.00; " 8.50; " " 9.00; " 4.50 "
" 12.00; " 7.00; " " 7.00; " 4.00 "

Animal, jaw, radula and *genitalia* not examined.

Distribution: New England to Utah, British America to Virginia.

Geological distribution: Pleistocene.

Habitat: In the larger lakes and rivers, attached to sticks, stones and débris.

Remarks: *Catascopium* is readily distinguished by its large aperture, and well rounded whorls. The height of the spire varies, in some specimens being one-half the length of the aperture (var. *pinguis*) and in others they are about equal. In the typical form the spire is gracefully conical, and the aperture and lower part of the shell are evenly rounded. The only species with which this species can be confounded is *Limnæa palustris*, but that species is generally larger, the spire is sharper and generally longer, and the surface is malleated, while *catascopium* is not. A comparison of the figures of the two species will suffice to separate them. *Catascopium* seems to be confined to the Northern and Southern regions, and has thus far been found only in Lake Michigan at Winnetka, Chicago and Miller's, Ind.

105a. Limnæa catascopium pinguis Say, pl. xxx, fig. 27.

Limnæa pinguis SAY, Journ. Phil. Acad., Vol. V, p. 123, 1825.
Limnæa catascopium BAKER (non SAY), Trans. Acad. Sci., St. Louis, Vol. XI, p. 4, pl. i, fig. 9, 1901.

Shell: Solid, thick, inflated; color light to dark horn; surface dull to shining, lines of growth numerous, fine, crowded, crossed by many impressed spiral lines; apex of good size, rounded, dark chocolate colored; whorls five, rounded, much inflated; spire short, conic; sutures impressed; aperture subovate or roundly ovate, half the length of the entire shell; peristome thin on the edge, thickened within by a white callus; columella reflected so as to cover the umbilicus, and with a rather heavy plait across the middle.

Length, 13.50; width, 8.75; aperture length, 8.00; width, 5.00 mill. (8388)
" 14.50; " 9.50; " " 9.50; " 5.50 " (8388)
" 14.00; " 9.00; " " 8.75; " 5.00 " (8388)

Animal, jaw, radula and *genitalia:* Not examined.

Distribution: Apparently the same as typical *catascopium*.

Habitat: Evidently similar to *catascopium*.

Remarks: Variety *pinguis* may be distinguished from typical *catascopium* by its shorter spire, more swollen whorls and generally heavier shell. It is not common in the Chicago area, and has been found only in the Calumet River. In a previous paper it was referred to typical *catascopium* but it is without doubt the short-spired variety *pinguis;* specimens referred to Mr. H. A. Pilsbry were so identified.

106. Limnæa woodruffi Baker, pl. xxxi, fig. 8.

Limnæa woodruffi BAKER, Bull. Chi. Acad. Sci., Vol. II, No. 4, p. 229, 1901.

Shell: Ventricose, very much inflated, solid; color greenish-horn or olivaceous; surface shining, growth lines distinct; rough in some specimens, crossed by numerous fine impressed spiral lines; apex small, rounded, light horn colored; whorls three to four, rounded, inflated, the last occupying nearly the whole of the shell; spire depressed; sutures impressed; aperture very large, roundly ovate, occupying about four-fifths of the length of the entire shell, roundly shouldered at the upper part; peristome thin, sharp; columella thickened, spreading, with a plait or fold in the middle; the lower part of the aperture is expanded, the columella callus making a ridge which is reflected over the umbilical region; umbilicus open, deep.

Length, 12.50; width, 8.00; aperture length, 8.50; width, 5.50 mill.
" 11.00; " 8.00; " " 8.00; " 5.00 "
" 11.50; " 8.00; " " 8.00; " 4.75 "

Animal, jaw, radula and *genitalia* not examined.

Distribution: Southern part of Lake Michigan.

Geological distribution: Pleistocene.

Habitat: Probably similar to *catascopium* and *emarginata*, but inhabiting rather deep water.

Remarks: This species has been a puzzle for several years and has been referred to both *decollata* and *catascopium*.* It certainly is not any form of *catascopium*, and judging by the figures in Binney, Haldeman and Tryon it is not *decollata*. Specimens of the latter received from the Philadelphia Academy of Sciences are decidedly different, the spire being longer, the number of whorls less and the shape of the aperture different. The principal characteristics of *woodruffi* are its very short spire, rapidly increasing and swollen whorls, and its roundly oval aperture with its broad shoulder at the upper part. It looks not unlike a miniature *Limnæa emarginata* var. *mighelsi*. Specimens sent to Mr. Bryant Walker were declared by him to be distinct from anything he had seen. The present species has been described as new, for the reason that in a lot of some two hundred specimens no individuals have been found connecting it with any known form. It has been found at Miller's, Ind., and along the lake shore, in Chicago, by Mr. F. M. Woodruff, to whom the species is dedicated.

107. **Limnæa desidiosa** Say, pl. xxx, fig. 20; pl. xxxi, fig. 7.

Limnæa desidiosa SAY, Journ. Phil. Acad., Vol. II, p. 169, 1821.
Limnæa modicella SAY, Journ. Phil. Acad., Vol. V, p. 122, 1825.
Limnæa acuta LEA, Trans. Amer. Phil. Soc., Vol. V, p. 114, pl. xix, fig. 81, 1837.
Limnæa philadelphica LEA, Proc. Amer. Phil. Soc., Vol. II, p. 32, 1841.
Limnæa plica LEA, Proc. Amer. Phil. Soc., Vol. II, p. 33, 1841.
Limnæa rustica LEA, l. c., p. 33, 1841.
Limnæa planulata LEA, l. c., p. 33, 1841.
Limnæa jamesii LEA, Proc. Phil. Acad., p. 113, 1864.
Limnæa desidiosa var. *decampi*, L. H. STRENG, The Nautilus, Vol. IX, p. 123, 1896. (Variety.)

Shell: Subconic, pointed, oblong, rather thin, sometimes

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*In the writer's paper on Limnæa before mentioned, pl. i, fig. 12, this form was referred to variety *pinguis* Say. The receipt of a large number of specimens has demonstrated that it is not that form.

inflated; color light or dark horn; surface shining, covered with numerous crowded, fine lines of growth, which can scarcely be discerned on the apex; whorls five, somewhat shouldered in some forms, the shoulder being near the suture; the last whorl is very large, half the length of the entire shell; each whorl is double the size of the one preceding; spire sharply-conical; sutures very deeply indented; aperture elongately ovate, somewhat expanded; peristome thin, acute; columella thickened by a testaceous deposit, and bearing a heavy plait across the middle; the columella is reflected at the lower end, the reflection almost covering the umbilicus, which is narrowly open; the umbilical region is somewhat indented. The surface is sometimes broken up by coarse, spiral semi-ridges into facets, forming a somewhat reticulated surface.

Length,	12.00;	width,	6.00;	aperture length,	6.00;	width,	3.00	mill.	(8457.)
"	12.00;	"	5.25;	" "	6.00;	"	3.50	"	(8457.)
"	10.00;	"	4.00;	" "	5.50;	"	2.50	"	(8457.)
"	8.75;	"	5.00;	" "	4.50;	"	2.50	"	(8457.)
"	13.00;	"	5.75;	" "	7.50;	"	4.00	"	(8468.)

Animal (Fig. 84): With a very small, more or less oblong foot, when viewed from the base, the anterior and posterior borders rounded; color dark gray or blackish, lighter below; the whole surface is dotted with whitish, which is specially noticeable about the eyes; tentacles triangular, flat, short, more or less transparent; the black eyes are placed on prominences at the inner base of the tentacles; respiratory orifice on the right side, near the angle of the peristome and body whorl. Length of foot 5.00, width 3.00 mill. The heart is situated near the umbilicus and the pulsations are very rapid; the writer counted one hundred and fifty to one hundred and fifty-five per minute.

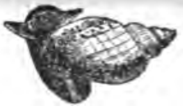

FIG. 84.
Animal of LIMNÆA DESIDIOSA Say. (Binney, Fig. 25.)

Jaw: As usual.

Radula formula: $\frac{30}{4}+\frac{9}{3}+\frac{7}{2}+\frac{1}{1}+\frac{7}{2}+\frac{9}{3}+\frac{30}{4}$ (46–1–46); central tooth as usual; lateral teeth with a subquadrate base of attachment, the reflection very broad, bicuspid, the inner cusp long, reaching below the lower margin of the base of attachment, the side cusp smaller; the eight to sixteen laterals are tricuspid, the inner cusp very small; these may be called intermediate marginals; marginals at first (seventeen to twenty) modified laterals, with a long, bifid inner cusp and two very short outer cusps; balance of marginals long and narrow, serrated, generally three short cusps at the distal end and two short cusps at the outer side; these latter disappear toward the outer part of the membrane (28–45); all have cutting points, especially well developed on the laterals and first marginals (Fig. 85).

Genitalia: Not examined.

Distribution: New England to Iowa, Canada, Manitoba and California, south to Virginia, Kentucky and New Mexico.

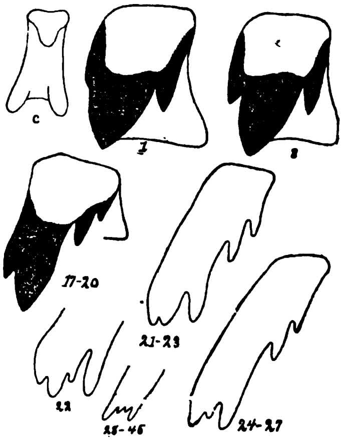

Fig. 85.

Radula of LIMNÆA DESIDIOSA Say. (Original.) c, central tooth; 1, first lateral; 8, lateral tooth; 17-20, modified marginals; 21-45, various types of marginals.

Geological distribution: Pleistocene; Loess.

Habitat: In small bodies of water, clinging to submerged stones and sticks. It occasionally inhabits the larger rivers. Prefers still water, and has been dredged in Lake Superior at a depth of 8 to 13 fathoms.

Remarks: This species is subject to some little variations and numerous names have been given to these forms.* In the main, however, it may be recognized by its long, pointed apex,

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*It is evident from a study of present material and the original figures and descriptions, that several other species will have to become synonyms of *desidiosa*; *L. obtussa* Say and *L. fusiformis* Lea may be considered doubtful species.

and elongately-ovate aperture. It approaches *L. humilis* in some of its forms, but that species is much smaller, has a shorter, more obtuse spire, and a more rounded base and aperture; the lower part of the latter is not produced as in *desidiosa*. When in motion the animal is slow and deliberate, the shell being pulled forward by a series of jerks. It is a very common *Limnæa*, and is found in all parts of the area. Fossil forms occur in sand banks on the lake shore north of Graceland avenue.

The spire and shell vary greatly in length and width, in some cases being long and narrow while in others they are shorter and the whorls more rounded. So great is this variation that, did not intermediate forms occur, the extremes would be worthy of specific distinction. The rounder, more graceful forms are figured on Pl. xxxi, Fig. 7.

108. **Limnæa humilis** Say,[*] pl. xxx, fig. 21.
Limnæa humilis Say, Journ. Phil. Acad., Vol. II, p. 378, 1822.
Limnæa parva LEA, Proc. Amer. Phil. Soc., Vol. II, p. 33, 1841.
Limnæa curta LEA, l. c., p. 33, 1841.
Limnæa exigua LEA, l. c., p. 33. 1841.
Limnæa griffithiana, LEA, l. c., p. 33, 1841.
Limnæa linsleyi DE KAY, Moll. of New York, p. 72, pl. iv, fig. 74, 1843.
Limnæa lecontii LEA, Proc. Phil. Acad., p. 113, 1864.

Shell: Thin, transparent to translucent, ovate-conic; color light horn, sometimes reddish; surface shining, covered with numerous crowded lines of growth, which are not much elevated and which disappear on the apex; whorls five, well-rounded, the last being a trifle longer than the spire in most specimens; spire obtusely conic; sutures impressed, sometimes indented; aperture oblong-ovate, somewhat expanded, narrowed at the upper part, generally a little longer than the spire; peristome thin, acute; columella oblique, covered with a thin testaceous deposit; the columella is reflected along the lower third, the reflection nearly covering the umbilicus which is narrowly open.

Length, 8.50; width, 4.00; aperture long, 4.50; width, 2.75 mill. (10488.)
" 8.00; " 4 50; " " 4.50; " 2.25 " (10488.)
" 7.25; " 3.50; " " 3.75; " 2.00 " (10488.)

Animal: In general form similar to *desidiosa;* color light brown or blackish, lighter on the foot, translucent about the edges of the body. Heart situated as in the last species, pulsations regular, one hundred and forty to one hundred and forty-six per minute.

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[*] It is probable that some names here given as synonyms will be found to constitute good varieties when a revision of the genus is made from abundant and authentic material. The same is true of *L. desidiosa*.

Jaw: As usual.

Radula formula: $\frac{12}{4}+\frac{4}{3}+\frac{6}{2}+\frac{1}{1}+\frac{6}{2}+\frac{4}{3}+\frac{12}{4}$ (22–1–22); central tooth as usual; lateral teeth bicuspid, the inner cusp very long and wide, bifid, the outer cusp smaller; marginal teeth long and narrow, the distal end four-cuspid, and two small denticles on the center of the outer margin (Fig. 86). A second example gave 15–1–15 teeth with six laterals. This latter was probably an incomplete membrane, as several examinations gave the result recorded above.

Genitalia: Not examined.

Distribution: New England to California, Canada to Georgia, Texas and New Mexico.

Geological distribution: Pleistocene; Loess.

Habitat: Similar to that of *desidiosa.* It seems to prefer the under side of boards, sticks and lily pads.

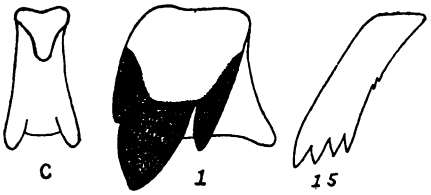

Fig. 86.
Radula of LIMNÆA HUMILIS Say. (Original.) c, central tooth; 1, first lateral; 15, ninth marginal.

Remarks: As remarked under the last species, *humilis* is closely related to *desidiosa.* It is always smaller (about one-half), is *rarely* malleated, and the spire is shorter and more conic and the aperture more rounded. This is one of our most abundant species and may be found by the hundred in any small pond or ditch, attached to submerged sticks, stones or vegetation. It is, like all the Limnæids, very sociable, and is always found in communities. *L. desidiosa, caperata* and *palustris* are almost always found associated with the species. It is as frequently out of water as in it, and this fact has led some conchologists to identify it as *Pomatiopsis.* Not long ago a number of specimens were given to the Academy by a gentleman who said they were found in wet moss, but not in the water at all. He thought, from this fact, that they must certainly be a land mollusk. The writer has had this species crawl over his desk like some of the land snails, which fact is true, in a lesser degree, of *L. caperata* and *desidiosa*. A form occurs at Berry Lake in which the spire is quite short, and the aperture longer than in the typical form. It is universally distributed.

109. Limnæa caperata Say, pl. xxx, fig. 18.
Limnæa caperata SAY, New Harm. Diss., Vol. II, p. 230, 1829.

Shell: Ovately elongate, rather solid, translucent; color yellowish horn to brown, sometimes black; surface shining or dull; lines of growth numerous and very fine; shell encircled by numerous irregular, raised spiral lines, which give the shell a somewhat latticed appearance; these spiral lines are placed on the epidermis and may be rubbed off with a brush; whorls five to six, convex, the last less than half the length of the shell; spire long, somewhat acute; sutures very heavily impressed; aperture ovate, its terminations more or less rounded, frequently reddish or purplish; peristome thin, sharp; columella strong, white, reflected so as to cover the umbilicus; there is a small fold crossing the center of the columella; umbilicus small, narrow, deep, frequently covered by the reflected columella.

Length,	12.00;	width,	5.50;	aperture length,	5.50;	width,	3.00 mill.	(10656.)
"	10.50;	"	5.00;	" "	5.00;	"	2.50 "	(10656.)
"	9.00;	"	4.50;	" "	4.00;	"	2.50 "	(10656.)
"	11.00;	"	5.50;	" "	5.50;	"	3.00 "	(10437.)
"	13.00;	"	6.00;	" "	6.00;	"	3.50 "	(12337.)
"	15.50;	"	7.00;	" "	7.50;	"	4.00 "	(12687.)

Animal: Black or bluish black, lighter below and minutely flecked with small, whitish dots, which are scarcely visible except on the top of the head; head distinct; tentacles short, flat, triangular; foot short and wide, 8 mill. long and 3 mill. wide. Heart placed a trifle below the center of the columella, the pulsations ranging from one hundred and twenty-nine to one hundred and thirty-three, somewhat irregular in movement.

Jaw: As usual.

Radula formula: $\frac{23}{4+}+\frac{3}{3}+\frac{7}{2}+\frac{1}{1}+\frac{7}{2}+\frac{3}{3}+\frac{23}{4+}$ (32—1—32); central tooth as usual; lateral teeth with a subquadrate base of attachment, the reflection longer than wide and bicuspid; the inner cusp very large, the outer cusp short; the eighth to tenth teeth are modified from laterals to marginals by the bifurcation of the inner cusp, and the splitting up of the upper part of the outer cusp into small denticles; the tenth tooth is trifid on the inner cusp and the eleventh and all that follow are of the usual form (Fig. 87).

Genitalia: Not examined.

Distribution: New England to California and Hudson Bay to Louisiana; Alaska (Randolph).

Geological distribution: Pleistocene; Loess.

Habitat: Found in small colonies in ditches and clear patches of swamp. It prefers submerged pieces of wood.

Remarks: This species is distinguished by its heavy spiral lines and long, acute spire. The animal is very rapid and decisive in its movements. Several specimens, kept together in captivity, ate holes in each other's shell for the lime for their own shells. This was at first attributed to cannibalism, but upon investigation this supposition was found to be incorrect. It is quite abundant and is one of the neatest Limnæids found in this area. An egg mass of this species was laid March 16, 1897. It contained forty-five eggs, distinctly nucleated, and in a jelly-like mass measuring 11 by 2 mill.

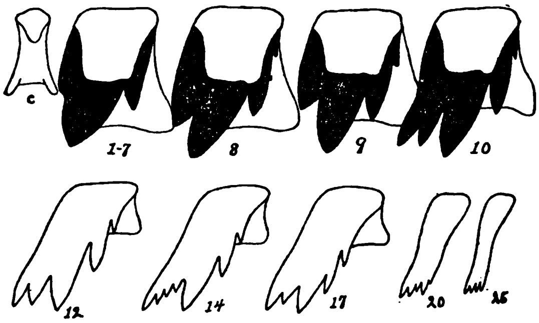

Fig. 87.

Radula of LIMNÆA CAPERATA Say. (Original.) c, central tooth; 1-7, lateral teeth; 8, 9, modified marginals; 10, first true marginal; 12, 14, 17, intermediate marginals; 20, 25, outer marginals.

On March 18th a second egg mass was laid, and on the 19th three more masses. On the 22d three individuals were seen in coitu, each one endeavoring to play the active part. Of the five egg masses laid each contained the following number of eggs: 42, 42, 35, 45, 28. The eggs were spherical in shape and very distinctly nucleated. One set of eggs was laid the morning of the 19th, and at noon of the 20th embryos were seen slowly rotating about, propelled by numerous cilia. The writer regrets that through some accident which occurred while moving from one house to another, the eggs became lost, so that he is unable to record any exact observations on the embryology of *caperata*.

109a. Limnæa caperata umbilicata Adams, pl. xxx, fig. 19.

Limnæa umbilicata ADAMS, Amer. Journ. Sci., ed. 1, Vol. XXXIX, p. 374, 1840.

Limnæa cubensis BAKER (non PFR.), Trans. St. Louis Acad. Sci., Vol. XI, p. 12, pl. i, fig. 1, 1901.

Shell: Ovate, solid, translucent; color yellowish or brownish horn; surface shining, growth lines fine and numerous; shell encircled by raised spiral lines; whorls five, very convex, the last whorl inflated, occupying from one-half to three-fifths of the total length of the shell; spire short, obtuse; conic, sutures much impressed; aperture roundly ovate, one-half to three-fifths the length of the shell, the terminations rounded; peristome thin, sharp, thickened inside by a reddish deposit; columella strong, reflected over the narrowly open umbilicus; columella with a small fold.

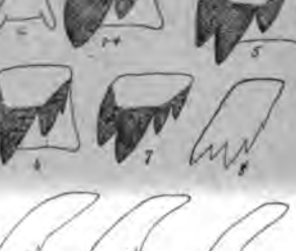

FIG. 88.

Radula of LIMNÆA CAPERATA UMBILICATA Adams. (Original.) c, central tooth; 1-4, lateral teeth; 5, 6, 7, transition teeth; 8, 9, 12, 20, marginal teeth.

Length,	10.00;	width,	5.00;	aperture length,	5.50;	width,	2.75	mill.	(10655.)
"	6.00;	"	4.00;	"	"	3.50;	"	2.00	"	(10655.)
"	6.75;	"	4.00;	"	"	4.00;	"	2.00	"	(10492.)
"	11.25;	"	6.50;	"	"	6.50;	"	3.50	"	(12475.)
"	14.00;	"	6.00;	"	"	7.00;	"	3.50	"	(12686.)

Animal: Similar to that of *caperata*.

Jaw: As usual, striated.

Radula formula: $\frac{2}{5}\frac{3}{4}+\frac{2}{4}+\frac{1}{3}+\frac{4}{2}+\frac{1}{1}+\frac{4}{2}+\frac{1}{3}+\frac{2}{4}+\frac{2}{5}\frac{3}{4}$(30–1–30);

central tooth as usual; first four laterals with a quadrate base of attachment, about as wide as high; reflection bicuspid, the inner cusp very large, the outer cusp smaller; fifth to seventh transitory, the inner cusp becoming split up into two cusps and a smaller cusp appearing on the outer side of the outer cusp; eighth, and all after true marginals, long and narrow, with from five to seven cusps; at first two of the cusps are situated some distance up the outer margin of the cusp, but finally (20) they appear only on the distal end (Fig. 88).

Genitalia: Not examined.

Distribution: Same as *caperata.*

Geological distribution: Pleistocene; Loess.

Habitat: Similar to and almost always associated with *caperata.*

Remarks: This variety was formerly identified as *cubensis* Pfr., but that species has a smooth shell and is more robust, grouping with *humilis* and *desidiosa* rather than with the *caperata* section. *Umbilicata* is doubtless a form of *caperata*, but seems distinct enough to constitute a separate variety characterized by a short spire and swollen whorls. Like *caperata*, the variety is universally distributed throughout the area, but is not quite so common. Fossil specimens have been found in sand banks along the lake shore north of Graceland avenue.

110. **Limnæa palustris** Müller, pl. xxxii, fig. 1.

Limnæa palustris MÜLLER, Zool. Dan. Prodr., 2934, 1776.
Limnæus elodes SAY, Journ. Phil. Acad., Vol. II, p. 169, 1821.
Limnæa umbrosa SAY, Amer. Conch., pl. xxxi, fig. 1, 1832.
Limnæa plebeia GOULD, Invert. of Mass., 1841.
Limnæa fragilis HALDEMAN (non Linné), Mon. p. 20, pl. vi (non figs. 10, 11), 1842.
Limnæa sumassi BAIRD, Proc. Zoöl. Soc., London, p. 68, 1863.
Limnæa palustris var. *zebra* J. W. TAYLOR, British Mollusca (vide Walker, in letter).

Shell: Varying from elongate to elongate-ovate, rather thin; color varying from pale brown to almost jet black; surface dull to shining, covered with numerous crowded growth lines crossed by several elevated spiral lines and by numerous very fine impressed spiral lines, which give the surface a malleated aspect; the whorls are sometimes encircled by coarse wrinkles, and frequently the epidermis is so arranged as to show longitudinal stripes of white and horn color, alternating; whorls six, rounded, the last varying in its rotundity; spire sharp and pointed, varying from over half to three-fifths the length of the entire shell; sutures well impressed; aperture roundly-ovate, more or less expanded; peristome thin, acute, sometimes expanded, in old specimens thickened by a heavy deposit within; the peristome is white and there is a band of very dark brown which edges the callus deposit; columella oblique, reflected, with a large fold across the middle, and covered by a heavy, whitish, testaceous deposit which is more or less spreading; umbilicus closed by the spreading callus and reflected columella, but the region is indented and the umbilicus is sometimes narrowly open.

Length,	27.50;	width,	9.50;	aperture	length,	12.00;	width,	5.00	mill.	(9323.)
"	23.00;	"	9.00;	"	"	11.00;	"	5.00	"	(8114.)
"	24.00;	"	10.00;	"	"	11.50;	"	5.50	"	(9884.)
"	30.00;	"	12.00;	"	"	14.00;	"	7.10	"	(8115.)
"	26.00;	"	12.00;	"	"	12.25;	"	7.00	"	(8115.)
"	20.00;	"	9.00;	"	"	9.00;	"	4.50	"	(9695.)
"	15.50;	"	7.00;	"	"	8.50;	"	3.50	"	(9695.)
"	26.50;	"	11.00;	"	"	11.00;	"	6.00	"	(9695.)

Animal: With a short, wide foot, rounded before and behind; tentacles short, triangular; color black, lighter below, the body spotted with white which shows through the shell. Heart situated as usual, pulsations regular, eighty to eighty-one per minute. Length of foot 8.00, width 3.00 mill.

Jaw: As usual.

Radula formula: $\frac{21}{4+}+\frac{4}{3}+\frac{9}{2}+\frac{1}{1}+\frac{9}{2}+\frac{4}{3}+\frac{21}{4+}$ (34—1—34); central tooth as usual; lateral teeth of the usual type, bicuspid; transition teeth at first like laterals but tricuspid, the central cusp the largest (eleven) but soon (thirteen) the inner cusps become more equal and the outer cusp small; marginal teeth of the usual type (Fig. 89). In one membrane examined (Fig. 90) the first lateral to the right of the central tooth had a bifid outer cusp. This was observed in all the first laterals in this membrane.

Genitalia: Not observed.

Distribution: North America, Europe, Asia; circumpolar. Alaska (Randolph).

Geological distribution: Pleistocene; Loess.

Habitat: Found in small streams and rivers, ponds and lakes, attached to floating sticks and submerged water plants.

Remarks: This is a very common and also a very variable species. It is always a wide, more or less fusiform species, with the aperture and spire equal, or the latter a trifle longer, but never twice as long, as in *reflexa*. The malleation is usually, though not always, present. There seem to be no geographic races to this form, as several varieties may be found in a single small pool, as is the case near Bowmanville. The lip may be thin or thickened, without regard to size. Some forms are ornamented by numerous fine, incremental lines, much as in some land shells.

The food of the *Limnæids* is supposed to be exclusively vegetable, but from some recent observations and from late notes of other naturalists it would seem that the group is carniverous as well as scavengiferous. The writer has noted this species feeding upon dead carcasses (dogs, cats, etc.), and Dr. Sterki (The Nautilus, Vol. V, p. 94, 1891) has seen it in the act of eating a living leech. The species is found in almost all parts of the area and in some localities is the predominating form.

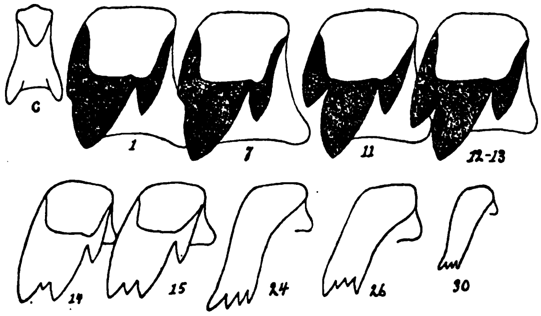

Fig. 89.

Radula of LIMNÆA PALUSTRIS Müller. (Original.) c, central tooth; 1, first lateral; 7, seventh lateral: 12-13, intermediate teeth; 14, 15, 24, 26, 30, marginal teeth.

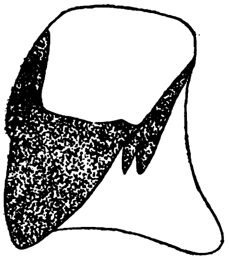

FIG. 90.

First lateral tooth of LIMNÆA PALUSTRIS Müller, with bifid outer cusp. (Original.)

The animal of *palustris* is very rapid in movement. It crawls out of the water and will remain in this position for a long time. When crawling, the shell is frequently moved rapidly from side to side, and is carried at all conceivable angles. It is a very rapid feeder and will soon clear up the sides of an aquarium. Like other species of the genus, *palustris* has the habit of rising very suddenly from the bottom to the top of the water where it will then float shell downward.

110a. Limnæa palustris michiganensis Walker, pl. xxxii, fig. 5; pl. xxxi, fig. 25.

Limnæa palustris michiganensis WALKER, The Nautilus, Vol. VI, p. 33, pl. i, figs. 9, 10, 1892.

This form is characterized by the aperture being about one-half the total length, the outer lip is thickened within by a bluish-white callus edged with brownish black; this shows as a white longitudinal band on the outside of the shell; spire acute, sutures impressed. Mr. Walker mentions very fine spiral lines, but these are as fully developed in the typical forms as in the variety.

Length, 20.00; width, 8.00; aperture length, 9.00; width, 4.50 mill. (12083.)
" 17.00; " 7.00; " " 8.50; " 4.00 " (12083.)
" 15.00; " 7.00; " " 8.00; " 4.00 " (12082.)

Habitat: Associated with the type, but not as numerous in individuals, and found from Michigan to Washington.

110b. Limnæa palustris nutalliana Lea, pl. xxxi, fig. 6.

Limnæa nutalliana LEA, Proc. Amer. Phil. Soc., Vol. II, p. 33, 1841; BINNEY, L. & Fr., Wat. Sh. N. A., p. 42, fig. 62, 1865.

Several specimens apparently referable to this form (which would appear to be a good variety of *palustris*) were collected recently by Mr. J. H. Ferriss, at Rock Run, near Joliet. The whorls in this species are more swollen and the sutures less impressed than in typical *palustris*. The epidermis is also peculiarly banded, the bands showing very plainly in the aperture. It has been found only at the above locality.

Length, 20.00; width, 8.50; aperture length, 10.00; width, 5.00 mill. (12343.)
" 18.00; " 8.50; " " 9.50; " 5.00 " (12343.)

Mr. Lea's description is appended for comparison.

"Shell ovately conical, rather thin, striate, subdiaphanous, pale brown, imperforate; spire rather short; apex red; sutures impressed; whorls six, convex; aperture ovate, inflated; banded within."

The original specimens were from Oregon.

110c. **Limnæa palustris expansa** Hald., pl. xxxii, fig. 2.
Limnæa expansa HALDEMAN, Mon., p. 29, pl. ix, figs. 6–8, 1842.
Limnæus sufflatus W. W. CALKINS, MSS.

This form seems distinct enough to constitute a variety. It is characterized by the spire and aperture being of equal length, the whorls inflated and the aperture expanded and shouldered at the upper part. In this area it has been found only in the Calumet River. The figure is from Calkins' type of *sufflatus*.

Length, 26.00; width, 13.00; aperture length, 15.00; width, 8.00 mill. (8375.)

111. **Limnæa ferrissi,** N. Sp., pl. xxxi, fig. 26.

Shell: Rather thin, elongated, scalariform, rimate; color light horn; surface dull to shining, lines of growth conspicuous, crossed by impressed spiral lines; whorls six, regularly increasing, convex, the last almost round; spire sharply conic, two-thirds the length of the entire shell; sutures deeply impressed; apex rounded, deep wine color; aperture roundly oval, one-third the length of the shell, brownish within; peristome thin, sharp, continuous; columella reflected, thickened by a callus, and with a faint plait; umbilicus narrow, deep.

Length, 11.00; width, 5.50; aperture length, 4.50; width, 3.00 mill.

Animal, jaw, radula and *genitalia* not examined.

Distribution: Rock Run, Joliet, Ill.

Habitat: Similar to *Limnæa palustris.*

Remarks: Ferrissi has a strong resemblance to *Limnæa holbollii* Beck and Möll., and if collected in Siberia or Greenland would certainly be so identified. The specimens under consideration were collected by Mr. J. H. Ferriss in Rock Run, near Joliet, and seem to constitute a very distinct species, characterized by rounded, scalariform whorls. It does not seem to be common and has been found only in Rock Run.

112. **Limnæa reflexa** Say, pl. xxxii, fig. 6; pl. xxxi, fig. 1.
Limnæa reflexus SAY, Journ. Phil. Acad., Vol. II, p. 167, 1821.
Limnæus elongatus SAY, l. c., p. 167, 1821.
Limnæus palustris var. *distortus* ROSSMASSLER, Icon., Vol. I, p. 97, pl. ii, fig. 52, 1835.
Limnæa lanceata GOULD, Proc. Bost. Soc. N. H., Vol. III, p. 64, 1848. (Variety.)
Limnæa zebra TRYON, Amer. Journ. Conch., Vol. I, p. 228, pl. xxiii, fig. 4, 1865.

Shell: Very much elongated, narrow, thin, sometimes scalar; color honey-yellow to black, sometimes obscurely longitudinally banded; surface shining, covered with numerous closely crowded growth lines, sometimes showing very fine impressed spiral lines which reticulate the surface; the growth lines are also wavy and elevated, in some specimens forming elevated ridges of considerable size; apex smooth, brownish or blackish; whorls six to seven, elongate-rounded, last whorl dilated (compressed in some forms), reflexed; spire very long and pointed, occupying about two-thirds of the entire length of the shell; sutures impressed; aperture lunate or elongate-ovate, narrowed at the upper part, very oblique in some specimens; peristome whitish, thin, sharp, thickened by a heavy callus on the inside, the callus chocolate or purplish in color; lower part of peristome dilated; columella oblique, with a heavy plait across its center, running up into the whorl and extending to the apex; the columella callus is heavy, wide and spreading, and, with the columella, is reflected so as to completely cover the umbilicus; umbilical region indented.

Length,	36.50;	width,	11.00;	aperture	length,	14.00;	width,	7.00	mill.	(8111.)
"	34.00;	"	10.00;	"	"	13.00;	"	6.00	"	(8111.)
"	30.50;	"	9.50;	"	"	12.50;	"	5.50	"	(8109.)
"	40.00;	"	13.00;	"	"	15.00;	"	8.50	"	(8109.)
"	38.00;	"	10.00;	"	"	13.50;	"	6.50	"	(8110.)
"	31.00;	"	9.50;	"	"	12.00;	"	7.00	"	(8110.)

Animal: Bluish-black or black; foot short and wide, 12.50 mill. long, 6.50 mill. wide; other characters as in *palustris*. The head is carried but little in advance of the edge of the shell.

Jaw: As usual.

Radula formula: $\frac{24}{4+}+\frac{6}{3}+\frac{10}{2}+\frac{1}{1}+\frac{10}{2}+\frac{6}{3}+\frac{24}{4+}$ (40—1—40); central tooth as usual; lateral teeth with a subquadrate base of attachment; reflection large, a little longer than wide; bicuspid, the inner cusp very large and sub-bifid, the second part represented only by a swelling on the inner side of the cusp; the outer cusp is short and narrow, and pointed; intermediate laterals and marginals tricuspid, the center cusp long, the outer cusps short; as the marginals are approached the reflection becomes narrow and the outer cusp is placed nearer the top of the tooth; marginal teeth long and narrow, of the usual type (Fig. 91).

Genitalia: Not observed.

Distribution: Northern United States and Canada, from the Atlantic to the Pacific.

Geological distribution: Pleistocene; Loess.

Habitat: Found plentifully in creeks, ponds, lakes and rivers, attached to pieces of floating wood, submerged vegetation, stones, etc. Also found attached to floating garbage, such as decaying apples, vegetables, etc.

Remarks: This is one of our most common species, and, excepting *L. stagnalis*, is the finest and largest *Limnæa* we have. It is always characterized by a long and attenuated spire which is generally twice as long as the aperture. In *palustris* the spire and aperture are nearly equal, and the shell is wider in proportion to its length than in *reflexa*, and the latter is very rarely malleated. There is great variation in the attenuation of the spire, which the figures well illustrate. The lip is sometimes continuous and entirely separated from the body whorl, and the whorls are swollen and separated by a deep suture, as shown on plate xxxi, Fig. 1. This is intermediate between the typical form and variety *scalaris*.

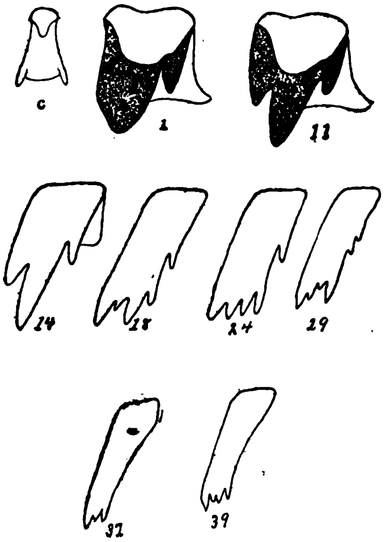

FIG. 91.

Radula of LIMNÆA REFLEXA Say. (Original.) c, central tooth; 1, first lateral; 11, 14, intermediate teeth; 18, 24, 29, 37, 39, marginals.

The animal is generally rather sluggish in movement, but sometimes moves with considerable rapidity, especially when feeding. The species is as widely distributed in the present area as *palustris*.

Dr. Howard N. Lyon has raised this species from the egg and has presented the set showing age-development to the Academy. Considerable variation is shown in the form of the shell, the young (twelve to sixteen weeks) looking very like *L. palustris*, the characteristic "twist" of *reflexa* not appearing until the twenty-first week. The measurements of the successive stages are as follows:

6 Weeks; length, 2.00; width, 1.50 mill.
12 " " 5.00; " 2.75 " } This set shows that some individuals grow faster than others.
12 " " 10.00; " 5.00 "
16 " " 13.00; " 6.00 "
16 " " 20.50; " 7.50 "
21 " " 21.50; " 9.00 "
21 " " 25.00; " 9.00 "
33 " " 26.50; " 9.50 "
52 " " 26.00; " 11.50 "
52 " " 28.50; " 10.50 "

Another remarkable set showing development was presented by Dr. Lyon. The tablet contains fifteen specimens which were all killed when seventeen weeks old, yet the smallest is 4 mill. long and the largest 27 mill. All were fed on lettuce and contained in a 4-quart battery jar, under equal conditions of heat and light, and the brood was from a single egg capsule.

112a. Limnæa reflexa jolietensis Baker, pl. xxxii, fig. 4.

Limnæa attenuata BAKER (non SAY), Trans. St. Louis Acad. Sci., Vol. IX, p. 20, pl. i, fig. 4, 1901.

Limnæa reflexa jolietensis BAKER, The Nautilus, Vol. XV, p. 17, 1901.

Shell: With an attenuated spire, which is more pointed than in reflexa; whorls seven, somewhat loosely coiled, very convex; leaving a well-marked suture; apex small, rounded, prominent; aperture about a third the length of the entire shell, lunate, thickened on the inside by a heavy callus; peristome thin; columella covered by a heavy callus and with a prominent plait; color light horn, sometimes darker, aperture dark horn, the callus yellowish, bordered with dark brown; other characters as in *reflexa*.

Length, 24.00; width, 8.00; aperture length, 9.50; width, 5.25 mill. (12309.)
" 23.00; " 7.75; " " 9.00; " 5.00 " (12309.)
" 22.00; " 7.00; " " 8.75; " 4.75 " (12309.)
" 29.00; mill. (Walker collection).

Animal, jaw, and *dentition* as in *reflexa*.

Genitalia: Not examined.

Distribution: Joliet, Illinois (Ferriss); Saginaw River, Mich. (Walker).

Habitat: Same as *reflexa.*

Remarks: This variety was erroneously identified as *attenuata* Say in a paper on Limnæa in the St. Louis Academy. Mr. Bryant Walker called the writer's attention to this error and suggested its description as a new variety, characterized by an attenuated spire, rounded whorls and a general scalariform aspect. It is fairly common at Joliet, but has not been found in any other part of the area.

Jolietensis has a close resemblance to variety *kirtlandiana*, but in the former the whorls are more rounded, increase more rapidly in size and the last whorl is differently shaped. The varieties *scalaris*, *kirtlandiana* and *jolietensis* are very closely related but seem to be easily distinguished.

112b. **Limnæa reflexa walkeri** Baker, pl. xxxi, fig. 2.

Limnæa reflexa var. *scalaris* BRYANT WALKER, The Nautilus, Vol. VI, p. 33, pl. i, fig. 7, 1892.

Not *scalaris* VAN DEN BROECK (Ann. Soc. Mal. Belg., Vol. V, p. 37, pl. ii, fig. 1, 1870, Vol. vii, p. 89, 1872), a variety of *Limnæa stagnalis.*

This form is intermediate between the typical *reflexa* and the variety *jolietensis.* It is in reality a scalariform condition, the whorls being well rounded and divided by a deep suture. The variety does not seem to be very common, and is always found, at least in this area, associated with the type. It may be collected sparingly in Lake Calumet and near Joliet.

Length, 37.00; width, 11.00; aperture length, 12.00; width, 6.00 mill.
" 28.00; " 9.00; " " 10.00; " 5.50 "

112c. **Limnæa reflexa kirtlandiana** Lea, pl. xxxi, fig. 4.

Limnæa kirtlandiana LEA, Proc. Amer. Phil. Soc., Vol. II, p. 33, 1841.

"*Shell:* Turreted, thin, irregularly striate, pale horn color, imperforate; spire attenuated; sutures impressed; whorls six, slightly convex; aperture narrow-elliptical. Diameter, .26, length .70 of an inch." (Lea.)

A number of shells answering in a general way to Lea's description were collected by the writer in Mud Lake, near Grand Crossing. They are small, none of them exceeding four-fifths of an inch in length. The whorls seem to be more rounded in some individuals than Lea's figure (Binney, Fig. 111) would indicate, but aside from this they agree very well. In some specimens the outer lip is thickened within by a heavy, white callus, bordered internally with very deep red or chestnut. The original locality was Poland, Ohio, and it has since been found in Michigan, Utah and Nebraska, which distribution shows that it is likely to be found anywhere within the area bounded by these localities. In the present region it has been found in Mud Lake, Berry Lake (collected by Prof. W. K. Higley), and in a ditch at Robey.

Length, 20.00; width, 7.00; aperture length, 7.50; width, 3.75 mill. (8382.)
" 18.00; " 6.00; " " 7.00; " 2.50 " (8382.)

112d. Limnæa reflexa exilis Lea, pl. xxxii, fig. 3; pl. xxxi, fig 3.

Limnæa exilis LEA, Trans. Amer. Phil. Soc., Vol. V, p. 114, pl. xix, fig. 82, 1837.

Limnæa reflexa variety BAKER, Trans. St. Louis Acad. Sci., Vol. IX, p. 19; pl. i, fig. 3, 1901.

Shell: Elongated, attenuated, thin; color light corneous or honey-yellow; surface shining, growth lines distinct, crowded, crossed by numerous very fine incremental striæ; apex smooth, very dark brown; whorls six to seven, flat-sided, rapidly increasing in size, the last a little over one-third the length of the entire shell; spire long and very much attenuated; sutures impressed, margined below by a white band which is frequently edged with chestnut; aperture elongate-ovate, slightly contracted at the upper part; peristome sharp, thin, a rather heavy callus within which is dark chestnut colored, the remainder of the aperture being brownish or horn color; this color shows on the outside as a light band; umbilicus closed; columella oblique, not twisted, covered with a thin callus and with a light plait.

Length, 37.00; width, 11.00; aperture length, 14 00; width, 6.00 mill.
" 30.00; " 9.00; " " 13.00; " 5.00 "
" 24.00; " 7.50; " " 10.50; " 4.50 "

Distribution: Mississippi Valley, occurring also in Michigan.

Remarks: This variety in its typical form is almost distinct enough to constitute a species, and might be so designated did not intermediate forms occur. The most pronounced distinguishing characters are the flat-sided whorls, particularly the last, the long, steeple-shaped spire and the shallow sutures. The peculiar twist, so characteristic of typical *reflexa*, is absent, as is also the wide aperture. The animal is similar to *reflexa*; the radula has the formula $\frac{24}{4}+\frac{6}{3}+\frac{10}{2}+\frac{1}{1}+\frac{10}{2}+\frac{6}{3}+\frac{24}{4}$ (40–1–40), the teeth being the same as those of *reflexa*.

This very distinct variety has been found only in the Calumet River, so far as at present known.

Among a lot of specimens from Calumet River, the individual which is here figured (Pl. 31, Fig. 3) was found. It is the slenderest specimen of *reflexa* yet seen, the whorls (seven and one-half) are just a trifle convex, the sutures somewhat impressed, and the spire very attenuated.

Length, 36.00; width, 9.50; aperture length, 14.00; width, 6.00 mill.

113. **Limnæa stagnalis* appressa** Say, pl. xxxiv, fig. 1.

Limnæa appressa SAY, Journ. Phil. Acad., Vol. II, p. 168, 1821.
Limnæa speciosa ZIEGLER of ROSSMASSLER, Icon. und Süssw. Moll., pt. I, p. 96, pl. ii, fig. 50, 1835.
Limnæa jugularis SAY, Nich. Encycl., Amer. ed., 1816. (Variety.)
Limnæa stagnalis var. *occidentalis* HEMPHILL, The Nautilus, Vol. IV, p. 26, 1890. (Variety.)
Limnæa stagnalis var. *sanctæmariæ* WALKER, l. c., Vol. VI, p. 31, pl. i, figs. 4, 5, 1892. (Variety.)

Shell: Elongated (or oval), ventricose at the anterior end, thin; color yellowish-horn to brownish-black; surface shining, growth lines numerous, crowded, more or less elevated, crossed by numerous fine, impressed spiral lines; apex smooth, brownish horn color; whorls six and one-half, rapidly increasing, all but the last two rather flat sided; last whorl very large, considerably dilated and inflated; spire long, pointed, acute, occupying about half the length of the entire shell (sometimes very short); sutures distinct, sometimes impressed; aperture large, broadly ovate, dilated, particularly at the upper part; peristome thin, acute, in some specimens thickened by an internal callus; lower part rounded; columella crossed in the middle by a very heavy plait, which starts from the base of the aperture and runs obliquely into the aperture of the shell about 10 mm. from the junction of the peristome with the body whorl; there is a spreading callus on the columella and labrum, which completely covers the umbilicus.

Lgth.,	48.00;	width,	21.50;	aperture	lgth.,	26.00;	width,	14.00	mill.	(8113.)
"	51.00;	"	22.50;	"	"	26.50;	"	15.00	"	(8113.)
"	33.00;	"	16.75;	"	"	18.50;	"	9.50	"	(8113.)
"	50.00;	"	20.00;	"	"	26.00;	"	12.00	"	(8113.)
"	62.50;	"	25.50;	"	"	33.00;	"	17.00	"	(coll. Jensen.)
"	57.00;	"	24.00;	"	"	31.00;	"	14.50	"	(12315.)

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*It seems hardly necessary, or worth the time expended, to name the numerous varieties of this species recognized by European writers, and yet it may be of some interest to tabulate the names of some of these varieties as recorded in the Annales de la Société Malacologique de Belgique, Vol. VII, 1872, p. 81, et seq. These are: *sinistrosa*, Jeff. (reversed), *lutea*, *maxima*, *expansa*, *quadrangulata*, *alba*, *erosa*, *regularis*, *distorta*, *aperta*, *biplicata*, *costulata*, all of Collin; *minima*, *gibbosa*, *illaqueata*, *aquarii*, *arenaria*, *producta*, all of J. Colb.; *rosea* Gass., *subfusca*, *major*, *pumila*, *turgida*, all of Moq.-Jan., var. *roseo-labiata* Wolf (Moq.), *fragilis* L. (Moq.), *scalaris* Broeck. This list simply shows to what extent the system of varietal naming may be carried.

Animal: Dark horn-colored, tinged with bluish on the foot; head distinct, separated from the body by a constriction or neck, and produced into lateral flaps or vela; tentacles triangular, rather long, flat, the eyes placed on their bases; foot short and wide, truncated before and roundly pointed behind, 20.00 mill. long and 9.00 mill. wide; respiratory orifice very large, placed near the junction of the peristome with the body whorl. Heart situated midway between upper and lower ends of columella, pulsations varying from thirty-seven to forty-eight per minute (Fig. 92).

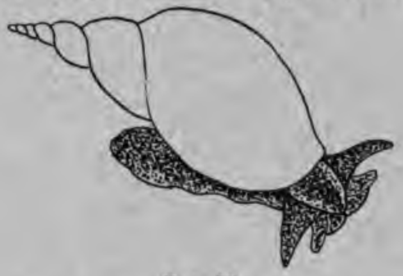

FIG. 92.
Animal of LIMNÆA STAGNALIS Linné. (Canadian Naturalist, Vol. II, p. 196.)

Jaw: As usual.

Radula formula: $\frac{29}{4+}+\frac{4}{2-3}+\frac{13}{2}+\frac{1}{1}+\frac{13}{2}+\frac{4}{2-3}+\frac{29}{4+}$ (46–1–46); central tooth as usual, a single membrane examined had the central tooth abnormal in possessing a denticle on the left side of the reflection (Fig. 93, c.); lateral teeth with a quadrate base of attachment, the reflection very large, reaching far below the base of attachment, bicuspid, the inner cusp very large, the outer cusp very small (the first lateral has a bifid inner cusp); intermediate teeth very long and narrow, bi- or tricuspid; marginal teeth very long and narrow, four or more cuspid, the cusps being very blunt and small and extending irregularly along the outer edge of the teeth. The number of teeth seems to vary in different individuals: the writer has counted from 46–1–46 to 54–1–54; Binney (L. and F. W. Sh., p. 28) gives 40–1–40 and (p. 155) 47–1–47 teeth; Bland and Binney (Am. Journ. Conch., Vol. VII., p. 161) give 40–1–40. It is probable that the membrane having 54–1–54 teeth was abnormal. 46–1–46 is the number generally counted by the writer (Fig. 93).

Genitalia: Not examined.

Distribution: North America, from the Atlantic to the Pacific Oceans.

Geological distribution: Pleistocene; Loess.

Habitat: Found generally in stagnant spots of ponds and rivers about decaying vegetation. Rotting fruit or vegetables floating in the water will be found a good habitat for this species. Dredged from a depth of ten meters at High Island Harbor, Lake Michigan. (Vide Bryant Walker.)

Remarks: This is our largest and finest *Limnæa*, easily distinguished by its great size, pointed spire and ample aperture. It varies to a great extent, principally in the form and size of the aperture, which is normally about the same length as the spire, but may be twice its length; it may also be elongately rounded or spreading and flaring. With all its variation, however, it is easily identified and cannot be mistaken for any other shell. This species may be classed with *palustris*, under the remarks on the latter species, in regard to its food. It has been seen about dead carcasses of a number of animals. So far as known it is confined to the southern and western regions.

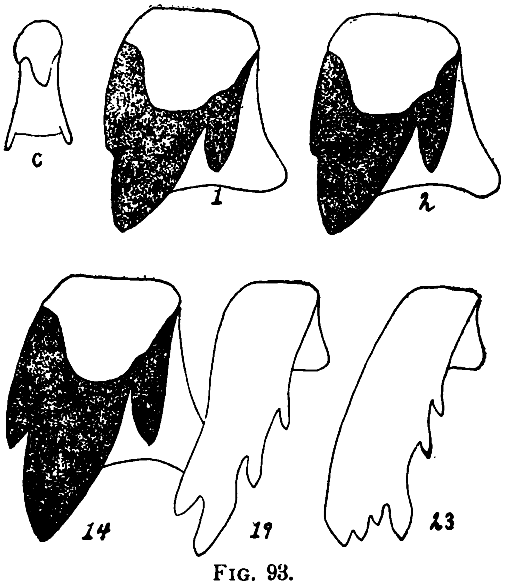

FIG. 93.

Radula of LIMNÆA STAGNALIS Linné. (Original.) c, central tooth (abnormal); 1, first lateral; 2, second lateral; 14, fourteenth lateral or first intermediate tooth; 19, 23, marginal teeth.

Mr. Bryant Walker has called the writer's attention to the fact that the typical *stagnalis* of Europe is not found in America. A study of numerous specimens has convinced the writer that this is true and that the typical American forms should be called var. *appressa*, as distinguished by Say years ago.

Subfamily Planorbinæ.

"Lateral jaws present," "Tentacles filiform." "Foot short." (Dall.) Genitalia on the right or left side.

GENUS **PLANORBIS** Guettard, 1756.

Shell: Dextral or sinistral, discoidal, with a flat, depressed spire which is visible from both sides; aperture crescent shaped or oval; peristome thin, simple, more or less expanded.

Animal: (Fig. 94.) With a short, ovate foot; tentacles slender, filiform, the eyes sessile at their inner bases; genitalia on left or right side; lateral jaws present; radula with subquadrate teeth, the central being bicuspid, the laterals tricuspid, and the marginals serrated; ova deposited in a thin envelope.

Genitalia: (*Planorbis corneus*, Bronn, Klassen und Ordnungen der Weichthiere, taf. ciii, Fig. 10.) The ovotestis is long and made up of a number of minute tubes; it is buried in the liver, as in Limnæa; the ovisperm duct is very long, convoluted at its upper part and terminates just below the albuminiparous gland, which is rounded and made up of rather large cells; the vas deferens is very long, thick at its upper part and narrow at its lower part, and enters the penis near its summit; the prostate is placed near the center of the vas deferens, and is about three times as long as wide; the oviduct is rather long, swollen at its lower part, where it enters the cylindropyriform vagina; the receptaculum seminis is cylindrical, and its duct is short and thick and enters the atrium near the female oriface (Fig. 95).

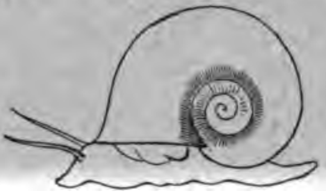

FIG. 94.
Animal of PLANORBIS. (Binney, Fig. 175.)

Distribution: World wide.

KEY TO SPECIES OF PLANORBIS.

A. Shell large, sinistral.
  a. Aperture not expanded.
    1. Apex sunk below the last whorl....................... *trivolvis*
    2. Apex flush with the last whorl....................... *truncatus*

b. Aperture expanded or bell-shaped.
   1. Both upper and lower surface forming a cone-shaped depression, the edge of the last whorl, above and below, bordered by a sharp carina..................*bicarinatus*
   2. Upper and lower surface on same plane, not forming a depression; all of the whorls visible above and two rounded whorls visible below. No carina...*campanulatus*

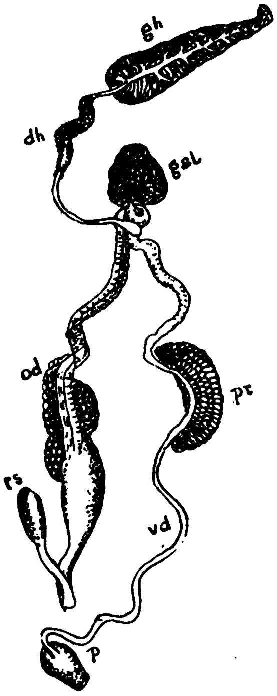

FIG. 95.

Genitalia of PLANORBIS CORNEUS. (Bronn, Klassen und Ordnungen der Weichthiere, Malacozoa, taf. CIII, Fig. 10.) dh, ovisperm duct; gh, ovotestis; gal, albuminiparous gland; od, oviduct; p, penis; pr, prostate; rs, receptaculum seminis.

B. Shell small, dextral.
   a. Periphery acutely keeled.
      1. Umbilicus narrow and rather deep..................*exacutus*
   b. Periphery rounded or obtusely keeled.
      1. Umbilicus shallow and broad.
         †Whorls well rounded, aperture ovate.................*parvus*
         ††Whorls angular, aperture deflected.................*deflectus*

SUBGENUS HELISOMA Swainson, 1840.

"Shell ventricose, whorls angulated. Spire sunk below the body whorl." (Dall.)

114. **Planorbis trivolvis** Say, pl. xxxii, figs. 7, 8, 9, 10.

Planorbis trivolvis SAY, Nich. Ency., pl. ii, fig. 2, 1817.
Bulla fluviatilis SAY, Journ. Phil. Acad., Vol. II, p. 178, 1821
Planorbis lentus GOULD, Invert. of Mass., p. 202, fig. 132, 1841. (Not of Say.)
Planorbis regularis LEA, Trans. Amer. Phil. Soc., Vol. IX, p. 6, 1841. (Juvenile?)
Planorbis megastoma DE KAY, N. Y. Moll., p. 61, pl. iv, figs. 60, 61, 1843.
Physa planorbula DE KAY, N. Y. Moll., p. 76, pl. v, fig. 83, 1843 (juvenile).
Planorbis trivolvis var. *fallax* HALDEMAN, Mon., p. 15, pl. iii, figs. 1-3, 1844.
Planorbis macrostomus WHITEAVES, Can. Nat., Vol. VIII, p. 113, fig. 1853. (Variety.)
Planorbis plexata INGERSOLL, Survey of the Terr, p. 402, 1874.
Planorbis distortus W. W. CALKINS, MSS.
Cochlea trium orbum LISTER, Conch., pl. cxl, fig. 46.

Shell: Sinistral,[*] discoidal, flat, carinate above, subcarinate below; color brownish or chestnut horn; surface shining, lines of growth oblique, numerous, raised, equidistant; apex almost submerged in the coils of the whorls; whorls four, discoidal, rounded, subcarinate below, carinate above; spire flat, in the young perfectly flat, but in the adult sunk below the level of the last whorl, always exhibiting all the volutions; sutures rather deeply indented; periphery rounded; base of shell indented, showing from two and a half to three volutions, which

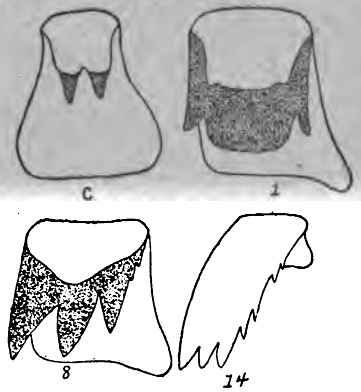

FIG. 96.

Radula of PLANORBIS TRIVOLVIS Say. (Original.) c, central tooth; 1, first lateral; 8, intermediate marginal; 14, seventh marginal.

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[*] There seems to be no question concerning the sinistral character of the majority of the genus Planorbis. The young of all the larger species are sinistral and very much resemble some species of Physa. For a detailed study of this subject see STEARNS, Proc. Phil. Acad., p. 92, 1881, and BAKER, Jour. Cin. Soc., N. H., Vol. XIX, p. 45, 1896.

are rounded and have very deep sutures between them; aperture broadly lunate, somewhat expanded below, and with a v-shaped angle above; the aperture is exactly the height of the body-whorl; peristome acute, thin, rounded, a little thickened on the inside and bordered within by a wide chocolate or yellowish band extending from one termination to the other; terminations approaching and connected by a very thin callus; interior of aperture bluish-white or horn colored; umbilicus narrow, deep, funnel-shaped.

Length.	Width.	Aperture Length.	Width, Mills.		
9.50	26.00	9.50	8.00	(8118.)	
8.00	23.00	8.50	7.50	(8118.)	
9.00	20.00	8.50	5.50	(8116.)	
7.00	18.00	6.50	5.50	(8396.)	(distortus.)
8.50	18.00	7.00	5.50	(8119.)	
8.00	17.00	7.00	6.50	(8119.)	
7.50	21.00	7.00	7.00	(8117.)	
8.00	22.00	8.00	7.00	(8117.)	
8.50	17.00	7.00	6.50	(8389.)	
4.50	5.50	4.25	2.00	(8732.)	Age development.
6.50	7.00	6.00	2.50	(8732.)	
7.25	12.00	7.00	4.50	(8732.)	

Animal: Dark brown, sometimes dotted with yellowish; foot short, wide, rounded before and behind; tentacles long, filiform, always in motion; head not separated from the rest of the body by a constriction; eyes situated on prominences at the inner base of the tentacles. Length of foot, 13.00, width 4.50 mill.; tentacles 11.00 mill. in length. Mantle margin simple. Heart pulsations seventy to seventy-four, very regular.

Jaw: With a median arcuated, crenulated plate and two narrow accessory plates.

Radula formula: $\frac{12}{8-7}+\frac{7}{3}+\frac{1}{2}+\frac{7}{8}+\frac{12}{3-7}$ (19—1—19); central tooth with a base of attachment longer than wide, swollen and rounded on the lower half; reflection bicuspid, broad, the cusps long and narrow, fang-like; lateral teeth with a quadrate base of attachment and a large, square reflection which is tricuspid, the center cusp being very wide and blunt and the side cusps long and narrow; intermediate teeth similar to laterals, but varying in the number and arrangement of the cusps; sometimes the change from laterals to marginals is abrupt, at others it is very gradual, and in some membranes there appear to be no two marginals alike; the large, blunt, central cusp in the lateral teeth becomes a long and narrow cusp in the intermediate teeth and the side cusps become much larger, so that all three cusps are about equal; in addition to this the outer edge of the cusp develops several small denticles; marginal teeth long and narrow, with three small cusps at the distal end, and several (three to four) small denticles on the outer edge (Fig. 96).

Genitalia: Not examined.

Distribution: Eastern North America, west to the Rocky Mountains; Manitoba. (Hanham.)

Geological distribution: Pleistocene; Loess.

Habitat: Found abundantly in the small streams and large bodies of water, either crawling on the muddy bottom or on sticks or other submerged objects, including vegetation.

Remarks: This is the most common, and at the same time one of the most variable, species found in the area under consideration. It is subject to much distortion, and several malformations have been given specific names (*plexata, distorta*); its size is extremely variable, and giant, or especially corpulent specimens, or those with an expanded peristome, have been described as distinct (*macrostomus*). It may always be distinguished by its sharp, simple lip, and by both sides showing almost the same number of whorls. The young shell looks like a *Physa* with the apex cut off. The animal is quite rapid in movement, and it is an interesting sight to observe one of these creatures moving along the glass side of an aquarium, with its long, filiform tentacles waving about, and its shell carried perfectly perpendicular. Dr. Sterki (Nautilus, Vol. V, p. 94), speaks of the peculiar "stepping" of this species. He says: "He goes a 'step,' as far as he conveniently can, with the shell deep down and close to the head; then he pushes it forward and upward, thus shoving the sand away and making room for another 'step.' It is more than probable that this digging is done not merely for locomotion—for he could do it much easier—but in search of food." The other species also perform this "stepping" act. The species is universally distributed throughout the area. During progression the shell is carried almost perfectly perpendicular, and the spire and base become the right and left side.

115. **Planorbis truncatus** Miles, pl. xxx, fig. 28.

Planorbis truncatus MILES, in WINCHELL'S Geological Survey, Mich., p. 238, 1861.

Shell: Sinistral, orbicularly discoidal, angulated and flat above, subcarinated and rounded below; color light chestnut or brownish; surface shining, lines of growth numerous, vertical, raised, equidistant, crossed by raised, equidistant spiral lines, giving the surface a latticed aspect; these spiral lines are developed on the lower, rounded surface and on the peripheral portion of the whorl, but not on the flat upper surface; apex distinct, pearly, a little raised above the whorls; whorls four, carinated above, subcarinated below; periphery rounded; spire flat, as though cut off, exhibiting all the volutions in the same plane; sutures separated by a raised carina; base of shell rounded, last whorl strongly keeled; umbilical opening round, wide, rather deep; aperture ovate, deflected and rounded at the lower part, flat and shouldered at the upper part; peristome thin, acute, not expanded, thickened by a heavy, white callus on the inside, which is bordered by a purplish band; interior of aperture whitish, showing the spiral and growth lines.

Length,	6.00;	width,	11.00;	aperture length,	6.00;	width,	5.00	mill.	(8397.)
"	6.00;	"	10.50;	" "	5.50;	"	4.00	"	(8397.)
"	7.00;	"	11.00;	" "	6.50;	"	4.00	"	(8397.)

Animal: Brownish in color, lighter on sides of foot and tentacles; tentacles one-half the length of foot, rather thick and blunt; foot wide, short, rounded at both ends (4.50 mill. long, 2.00 mill. wide, small specimen); head broad, auriculated; respiratory tube very large.

Jaw: As in *trivolvis.*

Radula formula: $\frac{12}{5+}+\frac{3}{3}+\frac{7}{3}+\frac{1}{2}+\frac{7}{3}+\frac{3}{3}+\frac{12}{5+}$ (22—1—22); the teeth seemed to be in all respects like *trivolvis.*

Genitalia: Not examined.

Distribution: Saginaw Bay, Mich. (Miles); Elk River, Antrim County, Mich. (Walker); Miller's, Ind. (W. K. Higley); North Branch Chicago River (T. Jensen); George Lake (T. Jensen); Chicago Drainage Canal, Summit, Ill. (Baker).

Geological distribution: Pleistocene.

Habitat: Found under conditions similar to *P. trivolvis.*

Remarks: This seems to be a very distinct species and is quite rare. While examining young specimens of *trivolvis* the writer was struck by the very close similarity between them and *truncatus.* This fact leads him to believe that the present species is a recent offshoot or variation from *trivolvis*, which is the parent stock. The truncated spire and latticed sculpture serve to distinguish this very beautiful species. It seems to be an inhabitant of deep water and only a very few specimens have thus far been collected in this area. The animal is very slow in movement and carries its shell at an angle of 45°. While watching this species (as well as others) feeding upon the glass sides of a jar, it seems evident that the entire radula is exserted when eating the growths on the glass, in exactly the same manner that a cat laps up milk. While feeding, the superior jaw may be plainly seen, as well as the radula.

116. **Planorbis bicarinatus** Say, pl. xxxii, fig. 12.

Planorbis bicarinatus SAY, Nich. Encycl., pl. i, fig. 4, 1817.
Helix angulata RACKETT, Linn. Trans., Vol. XIII, p. 42, pl. v., fig. 1, 1822.
Planorbis engonatus CONRAD, N. Fresh Sh. Suppl., p. 8, pl. ix, fig. 8, 1834.
Planorbis antrosus CONRAD, Amer. Journ. Science, I ser., Vol. XXV, p. 343, 1834.
Planorbis lautus H. ADAMS, Proc. Zoöl. Soc. London, p. 145, 1861.
Planorbis bicarinatus corrugatus CURRIER, Walker, The Nautilus, Vol. VI, p. 136, 1893. (Variety.)
Planorbis bicarinatus major WALKER, l. c., p. 136, 1893. (Variety.)
Planorbis bicarinatus var. *aroostookensis* PILSBRY, The Nautilus, Vol. VIII, p. 115, 1895. (Variety.)
Planorbis bicarinatus striatus BAKER, l.c., Vol. XV, p. 120, 1902. (Variety.)

Shell:—Sinistral, discoidal, angulated; color yellowish or brownish horn, sometimes dark brown or reddish; surface shining, lines of growth oblique, numerous, strong elevated, crossed by very minute striæ; apex small, but visible at the base of the cone-shaped depression formed by the spire; whorls three, discoidal, sharply carinated above and below; periphery rounded; spire exhibiting all of the volutions but forming a cone-shaped depression; sutures impressed; base of shell forming a deep umbilical depression which exhibits all of the volutions; aperture lunately-ovate, rounded below and v-shaped above, where it rises far above the body whorl; the aperture (usually) forms a slight bell-shaped enlargement, higher than wide; peristome thin, acute, expanded, thickened within by a bluish-white callus, and with a band of reddish-brown just back of this; extending from the termination above to the v-shaped depression below; terminations connected by a thin callus; interior of aperture whitish or brownish; sometimes there are two whitish spiral bands within the aperture, where the superior and inferior carinations make a shoulder, and extend far within the throat.

Length, 6.50; width, 13.00; aperture length, 6.00; width, 5.00 mill. (8487.)
" 5.50; " 9.00; " 4.00; " 3.00 " (8488.)
" 5.50; " 10.50; " 5.00; " 3.50 " (8486.)
" 5.50; " 10.00; " 5.50; " 4.00 " (9349.)

Animal: With a rather wide foot (6x3½ mill.) rounded before and behind; tentacles rather long and filiform, as long as, or longer than, the foot; head rounded and not so much auriculated as in *trivolvis;* color blackish, flecked with white on the foot and tentacles; respiratory tube large, blackish, flecked with white; eyes placed as usual.

Jaw: As in the genus.

Radula formula: $\frac{21}{5+}+\frac{3}{3}+\frac{6}{3}+\frac{1}{2}+\frac{6}{3}+\frac{3}{3}+\frac{21}{5+}$ (30 – 1 – 30); central tooth as usual; lateral teeth of the usual shape, but reflection with a large, squarish central cusp, a large, rounded inner cusp and a smaller outer cusp; intermediate teeth with three nearly equal, rather sharp cusps; marginal teeth as usual (Fig. 97). The writer counted 136 rows in one membrane.

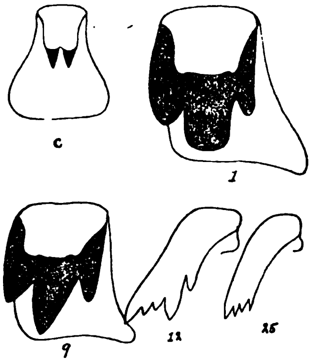

FIG. 97.

Radula of PLANORBIS BICARINATUS Say. (Original.) c, central tooth; 1, first lateral; 9, intermediate tooth; 12, third marginal; 25, outer marginal.

Genitalia: Not examined.

Distribution: United States and Canada, from New England to Manitoba, and south to New Mexico.

Geological distribution: Pleistocene.

Habitat: In rivers and ponds, in water from two to ten or fifteen feet in depth, on a muddy bottom.

Remarks: *Bicarinatus* is at once distinguished by the peculiar, cone-shaped depression on both the upper and lower surface, and by the characteristic v-shaped part of the aperture which rises above the body whorl. The species is quite abundant but is difficult to obtain alive on account of its preferring deep water. The animal is rather slow in movement, the head is carried much farther in advance of the foot than in *trivolvis.* It is an interesting sight to see one of this species crawling up the side of an aquarium, eating everything in its path. If a morsel that is distasteful is taken into the mouth, it will be immediately "spit out." In one specimen examined, the mantle cavity was infested by a small parasite (or messmate) which came out and went into the mantle chamber without causing the snail any apparent discomfort. *Bicarinatus* is found in all regions of the area, and has been collected fossil in sand banks on the lake shore, north of Graceland avenue, by Mr. Jensen.

SUBGENUS **PLANORBELLA** Haldeman, 1844.

"Shell few-whorled, aperture campanulate." (Dall.)

117. **Planorbis campanulatus** Say, pl. xxxii, fig. 11.

Planorbis campanulatus SAY, Jour. Phil. Acad., Vol. II, p. 166, 1821.
Planorbis bellus LEA, Proc. Amer. Phil. Soc., Vol. II, p. 32, 1821.
Planorbis bicarinatus SOWERBY, Genera, pl. iv (non Say).
Helix angulata SHEPPARD, teste J. de C. Sowerby, Fauna Boreali-Americana, Vol. III, p. 315.
Planorbis campanulatus minor CURRIER, Walker, The Nautilus, Vol. VI, p. 137.

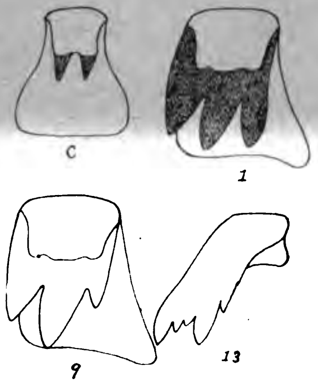

FIG. 98.

Radula of PLANORBIS CAMPANULATUS Say. (Original.) c, central tooth; 1, first lateral; 9, intermediate tooth; 13, third marginal.

Shell: Sinistral, discoidal, more or less rounded; color brownish-horn, sometimes reddish; surface shining, lines of growth oblique, very numerous, raised, equidistant for the most part; whorls four, discoidal rounded above and below, rarely subcarinated; spire flat, on a level with the general plane of the whorls, exhibiting all the volutions; sutures deeply impressed; periphery rounded; base of shell rounded, showing two volutions with a deep umbilicus in the middle; aperture lunate, the terminations of about the same shape, but rather more expanded below; the mouth of the aperture dilates to a great extent, forming a bell-shaped projection, a little wider than high; peristome thin, sharp, somewhat expanded, the terminations joined by a distinct callus; just within the aperture there is a heavy ridge, where the bulging begins; the diameter of the aperture, where the dilation begins, is but one-half that of the aperture at the ending of the dilation; interior of aperture bluish-white.

Length,	6.00;	width,	11.00;	aperture length,	5.00;	width,	4.00 mill.	(8481.)
"	6.50;	"	10.00;	" "	5.50;	"	5.00 "	(8481.)
"	7.00;	"	15.50;	" "	5.50;	"	5.00 "	(8484.)
"	7.00;	"	14.50;	" "	4.75;	"	4.75 "	(8485.)

Animal: Similar to that of *trivolvis;* color blackish all over; tentacles rather short and blunt; head very wide and auriculated; foot rounded before and rather pointed behind; 8 mill. long and 4 mill. wide. Heart beats seventy-two per minute. Some specimens appear of a greenish color when viewed through the shell.

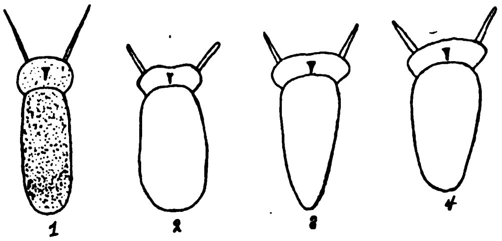

FIG. 99.

Under surfaces of the animals of PLANORBIS, showing variation in the shape of the foot while in progression. (Original.) 1, BICARINATUS; 2, TRIVOLVIS; 3, CAMPANULATUS; 4, TRUNCATUS.

Jaw: As usual.

Radula formula: $\frac{15}{5+}+\frac{3}{3}+\frac{7}{3}+\frac{1}{2}+\frac{7}{3}+\frac{3}{3}+\frac{15}{5+}$ (25 – 1 – 25); central tooth as usual; lateral teeth with three very nearly equal cusps; intermediate teeth and marginals as usual. The lateral teeth of this species differ considerably from those of *trivolvis*, *bicarinatus* and *truncatus* in having three very nearly equal cusps. Several examinations have been made to verify this statement and there seems to be no doubt of the accuracy of the same (Fig. 98).

Genitalia: Not examined.

Geological distribution: Pleistocene; Loess.

Habitat: Same as *bicarinatus.*

Remarks: *Campanulatus* is distinguished from all other Planorbes by its curious bell-shaped aperture. The flatness of the whorls will also help to distinguish it. This species, like *bicarinatus*, is an inhabitant of rather deep water and it is difficult to obtain alive without a dredge. It is universally distributed throughout the area. The animal of *campanulatus* is slow in movement and the shell is carried almost perpendicular.

In studying the last four species the writer has noted that there is considerable variation in the shape of the foot and head. *Bicarinatus* has a long foot and a large, rounded head, both flecked with white, and the tentacles are very long and filiform; *trivolvis* has a broad, rounded, blackish foot, a wide head and rather short, thick tentacles; in *campanulatus* the foot is pointed behind and is very black; and in *truncatus* it is narrower behind than before and is of a brownish color (see Fig. 99). If these four species be placed side by side these differences may be plainly seen.

SUBGENUS **MENETUS** H. and A. Adams, 1855.

"Shell depressed, whorls rapidly increasing. Periphery angulated." (Dall.)

118. **Planorbis exacutus** Say, pl. xxvi, fig. 5.

Planorbis exacutus SAY, Jour. Phil. Acad., Vol. II, p. 165, 1821.

Planorbis lens LEA, Trans. Amer. Phil. Soc., Vol. VI, p. 68, pl. xxiii, fig. 83, 1839.

Paludina hyalina LEA, Trans. Amer. Phil. Soc., Vol. VI, p. 17, pl. xxiii, fig. 81, 1839. (Monstrosity.)

Planorbis brogniartiana LEA, l. c., Vol. IX, p. 24, 1844; Proc., Vol. II, p. 242, 1842.

Planorbis lenticularis LEA, l. c., Vol. IX, p. 6, 1844.

Shell: Dextral, very much depressed, with an acute periphery; color pearly white; surface shining, slightly polished, lines of growth numerous, oblique, slightly elevated; apex distinct, on a level with the spire; whorls four, rapidly increasing, sloping in a well-rounded curve to the acutely keeled periphery; spire very flat, all the whorls in the same plane, or very slightly depressed at the apex; sutures impressed; base of shell flatly convex; umbilicus rather narrow, deep, exhibiting all the volutions; aperture obliquely ovate, sometimes obtusely triangular; peristome thin, acute, the superior part produced very much over the inferior part and expanded near the periphery; peristome a little thickened on the inside; interior of aperture pearly.

Length, 1.50; width, 5.00; aperture length, 1.40; width, 2.25 mill. (10278.)
" 2.00; " 7.50; " " 1.75; " 3.00 " (12359.)

Animal: Similar to *P. parvus;* color brownish; the foot is very short and rounded.

Jaw: As usual.

Radula: In all respects like that of *parvus.*

Genitalia: Not examined.

Distribution: Northern, Middle and Western States and Canada, south to New Mexico.

Geological distribution: Pleistocene.

Habitat: Found quite abundantly in rivers and ponds in water from four to five feet in depth, either on a muddy bottom or crawling among algæ.

Remarks: This is a distinct species easily known by its narrow umbilicus and very acute periphery. It is subject to considerable variation, and a number of names have been given to the different forms. Some of these forms are pure monstrosities and others simple local variations. In the present area it is found in the southern and western region.

SUBGENUS **GYRAULUS** Agassiz, 1837.

"*Shell:* Rounded above, flat beneath, whorls few, rapidly increasing." (Dall.)

119. **Planorbis parvus** Say, pl. xxvi, fig. 7.

Planorbis parvus SAY, Nich. Encycl., pl. i, fig. 5, 1817.

Planorbis vermicularis GOULD, Proc. Bos. Soc. Nat. Hist., Vol. II, p., 212, 1847. (Variety.)

Planorbis billingsii LEA, Proc. Phil. Acad., Vol. III, p. 109, 1864.

Planorbis circumstriatus TRYON, con. HALDEMAN'S Mon., p. 212, pl. vii, figs. 14–16, 1870. (Variety.)

Planorbis concavus ANTHONY, Cat. of Shells of Cin. (No descr.), 187–.

Shell: Small, dextral, depressed, with a well-rounded periphery; color bright horn to jet black; surface shining in the light colored specimens but dull in the black examples; lines of growth oblique, numerous, fine, slightly elevated, frequently crossed on the base by several raised spiral lines; apex not distinct, generally, but on a level with the rest of the spire; whorls four, rapidly enlarging; periphery rounded; spire flat, all the whorls in the same plane; sutures very deeply impressed; base concave, sometimes with raised revolving lines; umbilicus very wide, shallow, exhibiting all the volutions; aperture broadly-ovate, expanded, very nearly in the same plane as the last whorl; peristome acute, thin, the superior margin produced very much over the inferior margin, and expanded near the junction with the body whorl; interior of aperture yellowish-white or whitish; terminations of peristome connected by a thin callus.

Length,	1.00;	width,	3.00;	aperture	length,	.95;	width,	1.30	mill.	(10242.)
"	1.25;	"	4.10;	"	"	1.10;	"	1.25	"	(10243.)
"	1.25;	"	4.00;	"	"	1.10;	"	1.10	"	(10245.)
"	1.50;	"	5.00;	"	"	1.53;	"	1.50	"	(12360.)

Animal: Dark brown, lighter below; foot short, rounded; tentacles filiform, whitish, with a dark line on the center of the dorsal surface; respiratory groove long and narrow, whitish.

Jaw: With lateral plates present.

Radula formula: $\frac{10}{4-6}+\frac{8}{3}+\frac{1}{2}+\frac{8}{3}+\frac{10}{4-6}$ (18 – 1 – 18); central tooth with a base of attachment longer than wide, produced at the lower outer corner and excavated in the center of the lower margin; reflection bicuspid, the cusps short and wide; lateral teeth with a subquadrate base of attachment; reflection wide, tricuspid, the center cusp long and rather wide, the side cusps shorter; marginal teeth modified laterals in being low and very wide, the outer cusp splitting into 2–3–4 small cusps (Fig. 100.)

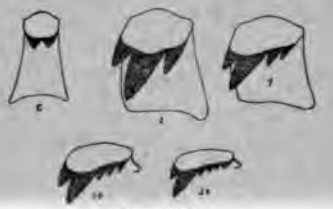

FIG. 100.

Radula of PLANORBIS PARVUS Say. (Original.) c, central tooth; 1, first lateral; 9, first marginal; 10, 13, marginals.

Genitalia: Not examined.

Distribution: Whole of eastern North America, west to Manitoba and California. Dredged in Lake Superior, at a depth of eight to thirteen fathoms.

Geological distribution: Pleistocene; Loess.

Habitat: Found in great abundance on the stems of water plants, submerged objects and among floating vegetation, such as *Spirogyra*.

Remarks: This is our most common small *Planorbis*, distinguished by its rounded aperture and periphery. It is so common in some localities that several thousand may be gathered in a few hours; the writer has observed them by hundreds in tangled masses of *Spirogyra*. The animal is quite active when temperature and external conditions are favorable. It progresses by a series of "steps" or jerks and pulls the shell after it, the latter being carried almost flat. *Parvus* is infested with two species of flukes which occur in great numbers in the muscular tegument of the lobes of the liver and the folds of the intestines. They have been named *Monostoma lucanica* and *Distoma ascoidea* by Dr. Leidy (Proc. Phil. Acad., p. 200–201, 1877.) It has been found in the ditches at East Chicago on submerged parts of *Utricularia vulgaris* Linné.

Several erratic forms (monstrosities) of this species have been found. Dr. H. N. Lyon found three specimens at the Chicago Avenue Water Works among some ten thousand normal specimens examined. The monstrosities are scalar for the most part, although one specimen was normal to the last half of the last whorl, when it suddenly became deflected. These erratic forms seem to be very rare.

120. **Planorbis deflectus** Say, pl. xxvi, fig. 6.

Planorbis deflectus SAY, Long's Expedition, Vol. II, p. 261, pl. xv, fig. 8, 1824.

Planorbis obliquus DE KAY, N. Y. Moll., p. 62, pl. iv, fig. 57, a, b, 1843.

Shell: Small, dextral, depressed, with an obtuse keel at the periphery; color light to dark horn, rarely jet black; surface shining, lines of growth numerous, fine, oblique; apex not distinct, sunk below the level of the whorls; whorls four to four and one-half, rapidly enlarging; periphery obtusely keeled; spire flat, all of the whorls, excepting the apical, in the same plane; sutures impressed; base concave; umbilicus wide, shallow, exhibiting all the volutions; aperture suboval, deflected, much wider than high (or long); peristome acute, thin, the superior portion produced as in *parvus*, thickened on the inside; terminations connected by a heavy white callus; interior of aperture yellowish-white or brownish.

Lgth., 2.00; width, 6.00; aper. lgth., 1.50; width, 2.00 mill. (12120.)
2.50; " 5.75; " " 1.50; " 2.00 " (12120.) distorted.
2.00; " 6.00; " " 1.50; " 2.00 " (12362.)

Animal: Similar to that of *parvus;* color blackish above, lighter on base of foot.

Jaw: As usual.

Radula: Similar to that of *parvus*. In a number of examinations the writer failed to note any differences of importance in the radulæ of these small species. The number of teeth seemed to be always 17-1-17 or 18-1-18.

Genitalia: Not examined.

Distribution: Maine west to Nebraska, Great Slave Lake south to Maryland.

Geological distribution: Pleistocene; Loess.

Habitat: Same as *parvus*, but preferring sticks and stones, and frequenting deeper water.

Remarks: This is the largest of our small Planorbies, distinguished from *P. parvus* by its obtuse peripheral keel and deflected aperture. Some distorted specimens show a scalariform tendency (No. 12120). Particularly large specimens have been collected at Bowmanville.

GENUS **SEGMENTINA**, Fleming.

Shell: Dextral, discoidal, depressed; spire on a plane with all the whorls; the interior of the whorls with numerous transverse teeth; aperture circular or oval; peristome simple.

Animal: Similar to that of *Planorbis;* foot narrow anteriorly, but wider and larger behind.

Jaw: Narrow, arched, pointed. For *Radula*, see under *armigera.*

Distribution: Europe, Asia, Australia, North America.

SUBGENUS **PLANORBULA** Haldeman, 1844.

All of the teeth in the aperture, except the last row, absorbed in the adult.

121. *Segmentina armigera* Say, pl. xxx, fig. 32.

Planorbis armigerus SAY, Journ. Phil. Acad., Vol. 11, p. 164, 1818.

Shell: Dextral, flat, somewhat carinated above and below the periphery; color pearl-white to reddish-brown, sometimes black; surface smooth, shining, lines of growth very fine, oblique; apex sunken below the level of the whorls, very small and rounded; whorls four, regularly and slowly increasing, obtusely carinated above and below the rounded periphery; spire concave, exhibiting all the whorls; sutures impressed; base of shell rounded; umbilicus round, deep, rather wide, concave, showing nearly all the volutions; aperture subovate, a trifle oblique, armed with five teeth, one on the parietal wall long, thin, S-shaped, extending in an oblique direction from a point near the upper carination of the body-whorl to a point near the lower carination; three on the peripheral wall, the two upper ones being prominent, short, thick and triangular, and the lower one more or less lamelliform and situated on the base of the aperture, and one small conic tooth near the superior junction of the peristome with the body-wall; peristome thin, acute, slightly thickened inside, the superior margin a trifle produced; interior of aperture pearly-white, with a band of reddish just within the aperture extending parallel to the edge of the aperture. In some specimens there is a sixth tooth, small, acute, elevated, just below the large one on the parietal wall; this, however, is not always developed (Fig. 101).

Length,	2.50;	width,	6.00;	aperture length,	2.50;	width,	1.25	mill.	(8473.)
"	2.00;	"	5.00;	" "	2.00;	"	1.00	"	(8478.)
"	2.75;	"	6.00;	" "	2.25;	"	1.50	"	(8474.)
"	3.00;	"	8.00;	" "	2.50;	"	2.00	"	(12363.)

Animal: With a rounded foot which is rather wide; head distinct, somewhat auriculate; tentacles very long and filiform, one and one-half-times as long as the foot; eyes placed as in *Planorbis;* color blackish, lighter on edge of foot and tentacles; respiratory groove long and pointed, thin and transparent. The foot measures 2½ by ½ mill.

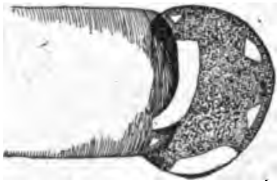

FIG. 101.

Aperture of SEGMENTINA ARMIGERA Say, showing number and position of teeth. (Original.)

Jaw: Not differing from that of *Planorbis.*

Radula formula: $\frac{9}{4+}+\frac{9}{3}+\frac{1}{2}+\frac{9}{3}+\frac{9}{4+}$ (18—1—18); central tooth with a long, narrow base of attachment, expanded on the lower, outer corners; reflection wide, bicuspid; lateral teeth wide, a trifle longer than wide, tricuspid, the center cusp long, wide and sharp, and the side cusps short and sharp; marginal teeth at first similar to laterals with the addition of a second small outer cusp; the marginals become wide and low toward the margin and three small outer cusps are developed (Fig. 102).

Genitalia: Not examined.

Distribution: Eastern, Middle and Western States and Canada.

Geological distribution: Pleistocene; Loess

Habitat: Found plentifully in the smaller streams, crawling over submerged sticks, stones and water plants.

Remarks: This interesting species is at once known by the denticles within the aperture, which can only be seen with a good lens. It is quite a common species, under favorable circumstances congregating by hundreds. Its movements are rather rapid, and when in progression its tentacles are constantly moving about. When eating, the mouth opens and closes very rapidly. It is found in the three regions of the area.

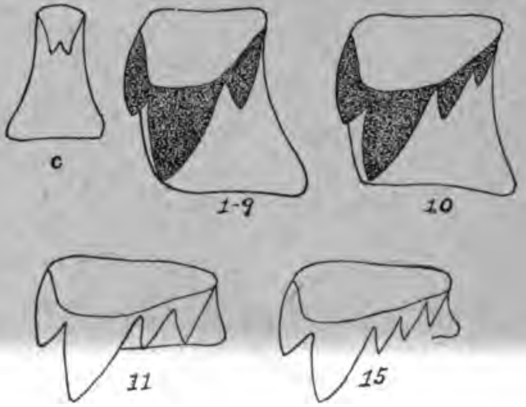

FIG. 102.

Radula of SEGMENTINA ARMIGERA Say. (Original.) c, central tooth; 1, first lateral; 10, first marginal; 11, second marginal; 15, outer marginal.

FAMILY ANCYLIDÆ.

"Lateral jaws present. Teeth resembling *Limnæa*. Shell patelliform. Hermaphrodite, but not capable of simultaneous reciprocal impregnation, as in the Limnæans." Dall.

GENUS **ANCYLUS** Geoffroy, 1776.

Shell: Patelliform, thin, conic; apex turned to the left, posterior; aperture as wide as the whole shell; peristome entire, simple; interior of shell with a subspiral muscle-scar.

Animal (Fig. 103): With a very large foot, oval in shape; tentacles short, stout, triangular, eyes situated at their inner bases; mantle margin simple; pulmonary orifice protected by a small lobe; genitalia on the left side; jaws three, thin, lateral plate fused with the superior jaw, ornamented with papillæ; lingual membrane broad, with numerous, crowded teeth; central tooth small, narrow, simple; lateral teeth broad, bicuspid, the inner cusp much the larger and bifid; marginal teeth serrated, longer than wide.

Genitalia: The genitalia of *Ancylus* is peculiar; the ovotestis is globular and the albuminiparous gland is very large, tubular, and placed very near the ovotestis; the oviduct and vas deferens are long and the penis is very long. The figure, from Bronn, is sufficiently characteristic without further description (Fig. 104).

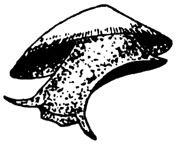

FIG. 103.
Animal of ANCYLUS. (After Binney.)

Distribution: North and South America, Europe and Australia.

KEY TO SPECIES OF ANCYLUS.

A. Apex placed centrally, shell conic.............................*tardus*
B. Apex placed posteriorly and directed to one side.
  a. Apex placed near the posterior end and a little to one side of the center. Shell depressed-conic..............*rivularis*
  b. Apex placed near the posterior end, at or close to the margin of one side. Shell very oblique.................*shimekii*

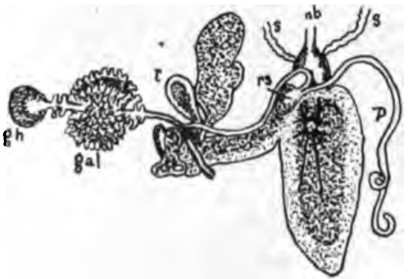

FIG. 104.
Genitalia of ANCYLUS FLUVIATILIS. (Bronn, Klassen und Ordnungen der Weichthiere, Malacozoa, taf. CIII, Fig. 16.) gh, ovotestis; gal, albuminiparous gland; nb, radula sac; p, penis; rs, receptaculum seminis; s, salivary glands.

122. ANCYLUS RIVULARIS Say, pl. xxx, fig. 29.

Ancylus rivularis SAY, Journ. Phil. Acad., Vol. I, p. 125, 1819.

Shell: Small, depressed-conic, fragile, sides nearly parallel, a trifle rounded but narrowed posteriorly; anterior slope long, convex, with a decided "hump" toward the apex; posterior slope short, concave; sides convex; apex prominent, elevated, obtuse, directed posteriorly and a little to the right side; the apex divides the shell into about three equal parts, one posterior and two anterior; aperture as large as the shell, narrowed posteriorly; peristome entire, simple, acute; color light horn; interior of aperture whitish.

Length, 3.00; width, 2.00; height, 1.25 mill. (12143.)
" 2.75; " 1.50; " 1.00 " (12143.)
" 5.00; " 2.75; " 2.00 " (13051.)

Animal: With a rather short and wide foot, emarginate in front, rounded behind; color plumbeous, finely dotted with white, with a yellowish line extending longitudinally on the head; head emarginate in front with lateral flaps; mantle simple, of good size; tentacles short, tapering, eyes placed near the inner bases of the tentacles; shell attached by a single large muscle in the apex of the shell. The foot measures 3.2 mill. in length and 1.00 mill. in width in an animal contained in a shell 5.00 mill. in length by 2.75 mill. in width (Fig. 105).

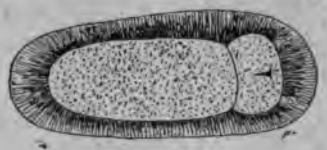

FIG. 105.

ANCYLUS RIVULARIS Say. (Original.) Animal viewed from the under side (enlarged).

Jaws: Thin, covered with papillæ; the lateral jaws are fused with the large upper jaw.

Radula formula: $\frac{11}{3^{\underline{4-5}}}+\frac{5}{3^{2}}+\frac{1}{1}+\frac{5}{3^{2}}+\frac{11}{3^{\underline{4-5}}}$ (16 – 1 – 16); the central tooth is simple as in Limnæa; the lateral teeth have a base of attachment longer than wide, the lower outer angle expanded; the reflection is very broad and bicuspid, the inner cusp being very large and semibifid while the outer cusp is smaller; there are also two very small denticles on the edge of the upper part of the outer cusp; the fifth lateral is somewhat narrower and the inner cusp is decidedly bifid, making the tooth practically tricuspid; the marginal teeth are very narrow, with a long, narrow reflection which is distally tricuspid, the central cusp being the larger, and the outer edge of the reflection serrated by about five small denticles. The bifurcation of the inner cusp of the lateral teeth is difficult to see, but the writer is certain of the fact, as it has been distinctly seen on a number of teeth. The cutting points are very well developed but are also difficult to see clearly. 90 rows were counted, and in one individual 20-1-20 teeth (Fig. 106).

Genitalia: Not examined.

Distribution: Northern, Middle and Western United States and Southern Canada south to New Mexico.

Geological distribution: Pleistocene.

Habitat: Found on living and in dead shells and on stones in small ponds and streams.

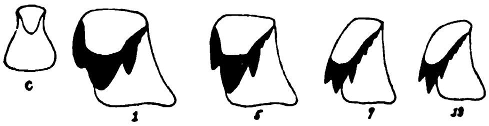

FIG. 106

Radula of ANCYLUS RIVULARIS Say. (Original.) c, central tooth; 1, first lateral; 5, fifth lateral; 9, fourth marginal; 13, eighth marginal.

Remarks: This small but distinct species may be known by its almost straight lateral outline and its apex, which is directed posteriorly and to the right side. It is quite abundant, but is almost always overlooked owing to its peculiar shape and inconspicuous habitat. The animal is very slow in movement and progresses similar to *Planorbis;* it is able to turn its body half way around without moving its shell. The buccal organs can be plainly seen while the animal is feeding. This species was noticed using its lingual membrane with a "lapping" motion, as described for some of the *Planorbes.* Large specimens have recently been found by Mr. F. M. Woodruff, in the sloughs back of Miller's, Ind.

123. **Ancylus tardus** Say, pl. xxx, fig. 30.

Ancylus tardus SAY, New. Harm. Dissem., Jan. 15, 1830; Mrs. Say's reprint, p. 26.

Shell: Small, conic, fragile, sides rounded; anterior a trifle longer than posterior, convex; posterior slope straight or a trifle concave; sides rectilinear; apex prominent, elevated, obtuse, rounded, a little posterior of the center but not directed laterally; the apex very nearly divides the shell into two equal parts; aperture as large as the shell, rounded; peristome simple, entire, acute; color greenish-horn.

Length, 6.00; width, 4.00; height, 3.00 mill.

Animal: Not examined.

Jaw: Not examined.

Radula: Not examined.

Genitalia: Not examined.

Distribution: Same as *rivularis*.

Geological distribution: Pleistocene.

Habitat: Similar to *rivularis*.

Remarks: This species is wider and more conical than *rivularis*, and the apex is more central and *not* directed laterally. It seems to be very rare and has been found only in the DuPage River.

124. **Ancylus shimekii** Pilsbry, pl. xxxi, figs. 9, 10.

Ancylus obliquus, SHIMEK, Bull. Lab. Nat. Hist. Univ. of Iowa, Vol. I, Nos. 3-4, p. 214, pl. iii, figs. 5^a, 5^b, 5^c, 1890. (Preoccupied.)

Ancylus shimekii PILSBRY, The Nautilus, Vol. IV, p. 48, 1890.

"*Shell:* Elevated, thin, transparent, horn-colored, with a yellowish-brown epidermis; aperture ovate, conspicuously wider anteriorly, in many (especially young) specimens slightly reniform by a barely perceptible incurving of the right margin, the anterior, left and posterior margins regularly rounded, the right slightly incurved, straight, or but slightly convex; apex somewhat acute, elevated, strongly deflected posteriorly and to the right, and curved downward, in most specimens quite overhanging the posterior right margin of the shell; the apical portion of the shell (one-half or more) is strongly laterally, or rather, obliquely, compressed, a character which makes the young appear proportionally much narrower than the adults; the anterior slope of the shell is long and strongly convex, the posterior being short and concave. The surface is marked by fine lines of growth." (Shimek.)

Length, 3.50; width, 1.80; height, 1.50 mill. (Shimek.) Large specimen.
" 2.70; " 1.70; " 1.20 " (Shimek.) Average measurement.
" 3.10; " 1.70; " 1.10 " Joliet specimen.

Animal: "Uniform bluish-white color; the foot is ovate, wider anteriorly, and rather narrow for an *Ancylus*." (Shimek.)

Radula: "Rather narrow, the dental formula being 12-1-12." (Shimek.)

Distribution: Five miles east of Lincoln, Neb., in Dead

Man's Run (Shimek); Rock Island, Ill. (Pilsbry); Rock Run, Joliet, Ill. (Ferriss).

Geological distribution: Unknown.

Habitat: Found at all seasons of the year adhering to shells of *Anodonta plana*, sticks, leaves, etc. (Shimek.) Found at Rock Run on sticks and leaves.

Remarks: This comparatively rare species is known by its very oblique shell; in some individuals the apex fairly overhangs the margin. It has been found only at Rock Run, Joliet, but will probably be discovered at other localities by careful and patient search. The shell has some resemblance to the genus *Gundlachia*, and Mr. Pilsbry (Nautilus, IV, 48) says of it: "Certain indications led me at the time of finding this shell" (speaking of a specimen found at Rock Island, Ill.), "to refer it to *Gundlachia* instead of *Ancylus;* and it may be worth while to follow this clew further. If my supposition proves to be correct, *Gundlachia* will furnish the most extraordinary case of dimorphism known among American mollusks."*

FAMILY PHYSIDÆ.

"*Foot:* Pointed behind. Buccal plate (when present) without accessory laterals. Lateral teeth comb-like, alternating with simple cusps. Base of central tooth broad, bifid; cusp with several denticles." (Dall.)

"*Genitalia:* On the left side." (Dall.)

GENUS **PHYSA** Draparnaud, 1801.

Shell: Thin, polished, sinistral; spire more or less acute; aperture oval, rounded in front; columella provided with a callus which is spread over the last whorl; peristome acute.

Animal: With a long foot, rounded before, pointed behind; mantle reflected over a portion of the shell and fringed with finger-like filaments; tentacles long, slender, pointed; eyes situated at their inner bases; genitalia on left side; jaw chevron-shaped or absent, finely striated, with a central fibrous projection; radula as described for the family (Fig. 107).

The Physæ are the most difficult to study of the fresh water shells. So variable are their specific characters that no less than seventy species have been described, and the subject is in such confusion that few students care to attempt their study or collection.

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*See also The Nautilus, Vol. IX, p. 63, 1895, for further notes on this subject by Mr. Pilsbry.

The writer has attempted to revise the species found in Northern Illinois, and the late Mr. O. A. Crandall, of Sedalia, Mo., has published some very valuable notes on the American Physæ in The Nautilus for 1901. This gentleman believed that the most reliable characteristics for determination were texture, structure and sculpture. He also considered that the length of time required for a species to reach maturity might also serve as a character of importance. He found, as have other students of this family, that some species attain their full growth in one year while others require two or three. He therefore proposed the terms annuan, biannuan and triannuan for the species which reach maturity in one, two and three years. As a whole, the writer agrees with the conclusions of Mr. Crandall.

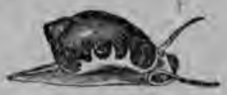

FIG. 107.
Animal of PHYSA. (Binney, Fig. 123.)

Distribution: North America, Europe, East Indies.

KEY TO SPECIES OF PHYSA.

A. Shell smooth, broad, spire short. Annuan.............. *heterostropha*
B. Shell with impressed spiral lines.
  a. Shell rather broad, ovate, spire short, acute; aperture wide and spreading; whorls four and one-half to five; shell thinner than b; peristome callus bordered by red. Annuan.. *sayii*
  b. Shell elongated or cylindrical, narrow, spire generally long; aperture very narrow; whorls five to six; peristome callus bordered by red. Triannuan................. *gyrina*
  c. Shell broad, inclining to be shouldered; spire sharply conic; aperture roundly oval; peristome callus white, without red border. Biannuan.......................... *integra*

125. **Physa heterostropha** Say,* pl. xxxiv, fig. 2.
Limnæa heterostropha SAY, Nich. Encycl., Amer. ed., pl. i, fig. 6, 1817.
Physa fontana HALDEMAN, Mon., pt. 2, p. 3 of cover; Physa, p. 26, 1841.
Physa heterostropha alba CRANDALL, The Nautilus, Vol. XV, p. 29, 1901.

Shell: Polished, subovate, whorls four to four and one-half; spire moderately elevated, acute, the whorls slightly convex; color varying from light horn to greenish; sculpture consisting only of fine growth lines (Fig. 108); sutures impressed, margined by a white line which is frequently bordered by a dark chestnut line; protoconch consisting of one whorl, which is smooth and varies from porcelain-white to rather dark horn color; aperture rather large, oval, occupying from two-thirds to three-fourths of the length of the entire shell; peristome thin, acute, thickened on the inside by a whitish or bluish callus, which is bordered on the inside with red; columella almost straight, with a whitish callus which is sometimes lined with red.

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*The greater part of the subject-matter on Physa was published in The Nautilus, Vol. XIV, pp. 16-24, 1900.

Length.	Width.	Aperture Length.	Width.	
14.00	8.50	10.00	4.00 mill.	(Rochester.)
13.00	8.50	10.00	4.50 "	(Rochester.)
13.50	9.00	10.50	4.50 "	(La Porte, Ind.)
9.00	6.00	6.50	3.00 "	(13361.)

Animal: Similar to that of *gyrina.*

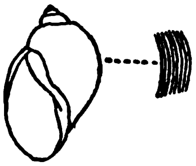

FIG. 108.
Surface sculpture of PHYSA HETEROSTROPHA Say. (Original.)

Jaw and *Radula:* In all respects like those of *gyrina.*

Genitalia: Not observed.

Distribution: Eastern and Southern States; Maine to Georgia and west to Michigan and Illinois; Southern Canada.

Geological distribution: Pleistocene; Loess.

Habitat: In ponds and streams, adhering to sticks and stones and crawling over the muddy bottom.

Remarks: During a visit to the Philadelphia Academy of Sciences some time ago, Mr. Pilsbry called the writer's attention to the fact that *heterostropha* had a smooth shell, while *gyrina* and some others had a shell with raised (or, as the writer would describe them, impressed) spiral lines. Following up this suggestion a large number of *Physæ* have been examined with the result that instead of there being two species in the present area, as was at first supposed, there are four, with one or more varieties. *Heterostropha* is an annuan, attaining full maturity in one year.

Only a single lot of shells has been found which could be referred to this species, and that was collected in the drift along the shores of Lake Michigan, at Miller's, Ind. The nearest of typical *heterostropha* have been found living in Pine Lake, La Porte County, Ind. It is very probable that this species is not found in any abundance west of Indiana, its place being taken by *gyrina*, *sayii* and *integra*. Under distribution, above, only those states are given from which the writer has seen authentic specimens.

126. **Physa sayii** Tappan, pl. xxxiv, fig. 3, 7; pl. xxxii, fig. 13.
Physa sayii TAPPAN, Amer. Journ. Sci. (i), Vol. XXXV, p. 269, pl. iii, fig. 3, 1889.
Physa warreniana LEA, Proc. Phil. Acad. Sci., p. 115, 1864.

Shell: Sinistral, polished, ovate, whorls five to five and one-half; spire elevated, very acute, the whorls moderately convex; color light horn to light chestnut; sculpture consisting of rather coarse growth lines, crossed by numerous fine, impressed spiral lines, giving the surface of the shell a wavy appearance, as figured for *P. gyrina;* sutures slightly impressed, bordered as in *heterostropha;* protoconch consisting of one and one-half smooth, glossy whorls of a dark chestnut color; aperture very large, long-oval, three-fourths to four-fifths the length of the whole shell; peristome thin, generally not very much thickened within, whitish, sometimes bordered with reddish; columella slightly twisted and covered with a spreading callus; the lower part of the aperture is somewhat produced.

Length, 22.00;	width, 13.50;	aperture length, 16.00;	width, 7.50 mill.
" 19.00;	" 12.00;	" " 14.00;	" 6.00 "
" 16.00;	" 11.00;	" " 12.00;	" 6.00 "

Animal: Similar in external appearance to all Physidæ.

Jaw and *Radula:* As in *gyrina.*

Genitalia: Not observed.

Distribution: Northern United States and Southern Canada west to the Rocky Mountains and south to the Ohio and Missouri Rivers.

Geological distribution: Pleistocene; Loess.

Habitat: In stations similar to *heterostropha* and *gyrina.*

Remarks: This species was at first identified as *P. ancillaria* Say, but that species, while having the same surface sculpture as *sayii*, is more inflated, the outer lip more spreading and the body whorl more gibbous, the spire being *always* much shorter and the whorls more convex. The surface sculpture is very beautiful and precisely as described for *gyrina*. This species has been found in all the regions, at Joliet, Maywood, Lake Calumet and Lake Michigan near Oak street. *Sayii* is apparently closely related to *P. ampullacea* Gould, a Pacific Coast species.

Sayii appears like *gyrina* and some other species, to be dimorphic, having a short- and a long-spiral form. Were it not for the closely connecting individuals, the short-spiral form would be worthy of varietal distinction; see plate xxxii, fig. 13, and plate xxxiv, fig. 7, where the short-spired form is figured. *Sayii* is an annuan.

127. **Physa gyrina** Say, pl. xxxiv, fig. 4.

Physa gyrina SAY, Journ. Acad. Nat. Sci., Phil., Vol. II, p. 171, 1821.
Physa striata MENKE, Syn. Meth., ed. 2, p. 32, 1830.
Physa hildrethiana LEA, Proc. Amer. Phil. Soc., Vol. II, p. 32, 1830.
Physa cylindrica NEWCOMB in DE KAY, N. Y. Moll., p. 77, pl. v, fig. 82, 1843.
Physa plicata DE KAY, l. c., p. 78, pl. v, fig. 85, 1843.
Physa hawnii LEA, Proc. Phil. Acad., p. 115, 1864.
Physa parva LEA, l. c., p. 115, 1864.

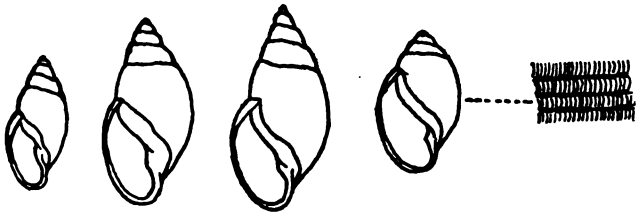

FIG. 109.
Surface sculpture of PHYSA GYRINA Say. (Original.)

Shell: Elongated, generally polished, whorls five to six; spire always very long, as compared with the last two species, acute, the whorls in some cases almost flat, and at best but slightly convex; color varying between light greenish horn and brick red; sculpture consisting of well-marked growth lines, crossed by numerous fine impressed spiral lines, giving the shell a wrinkled appearance (Fig. 109); these lines appear at first to be raised, but when viewed through the microscope are seen to be impressed between two wrinkled ridges, as shown in the cut; sutures scarcely impressed, bordered by a porcelain-white line which is rarely edged with chestnut; aperture rather long, long-oval in form, much narrowed at the upper part, more than a half and less than two-thirds the length the entire shell; peristome thin, thickened on the inside by a callus which is either bordered by a dark chestnut band or else is itself of that color; columella thickened with a decided white callus or plait; the lower part of the aperture is produced; the periods of winter hibernation are frequently marked by a whitish band in the body of the shell; protoconch consisting of a trifle more than one smooth, rounded, dark chestnut-colored whorls.

Length, 17.00; width, 9.00; aperture length, 11.00; width, 4.50 mill. (9331.)
" 26.00; " 12.00; " " 14.00; " 5.50 " (8493.)
" 24.00; " 11.50; " " 13.00; " 5.00 " (8493.)
" 19.00; " 10.00; " " 12.00; " 5.00 " (8493.)
" 22.00; " 10.00; " " 12.50; " 5.00 " (8471.)

Animal: With a long, rather narrow foot, acutely pointed behind and rounded before, where it is produced into two lateral lobes (vela); the foot does not extend much beyond the edge of the shell, color blackish or yellowish gray, dotted or flecked with whitish or yellowish, the dots being distinctly seen through the transparent shell; the front of the head is ornamented with two yellowish spots of good size, composed of numerous minute dots; the mantle is brown, spotted with yellowish, is reflected over a portion of the shell on the right side and produced into 4–10 filiform digitations arranged in two series apical and columella; tentacles very long and slender, tapering to a point; head distinct, separated from the foot by a short neck; mouth large, in the lower plane of the head, showing plainly the jaw and radula while the animal is grazing along the side of an aquarium; eyes placed on swellings at the inner base of the tentacles; respiratory cavity on left side of shell at the lower point where the peristome meets the body whorl. Length of foot, 15.00 mill.; width, 4.00 mill. (Fig. 110).

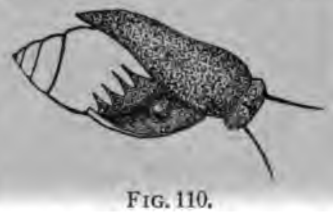

FIG. 110.
Animal of PHYSA GYRINA Say. (Original.)

Jaw: In one piece, arched, striated, provided with a central fibrous projection from the superior surface; ends rounded (Fig. 111).

Radula formula: $\frac{95}{5}+\frac{95}{1}+\frac{}{2}-\frac{1}{5}-\frac{}{2}+\frac{95}{1}+\frac{95}{5}$ (190 – 1 – 190); central tooth more or less quadrate, the lower outer corners being very much attenuated; cusp nine-dentate, five denticles being long and narrow and two on each side small and blunt; laterals in two alternate series, the primary teeth large, obliquely inclined, comb-like, five-dentate, with a varying number of small denticles between the five large cusps. The secondary teeth are long and narrow, with a wide, blunt cusp. These latter, as also the central tooth, are very difficult to observe (Fig. 111).

Genitalia: Not observed.

Distribution: Probably inhabits the whole of the Northern and Central parts of the United States and Southern Canada.

Geological distribution: Pleistocene; Loess.

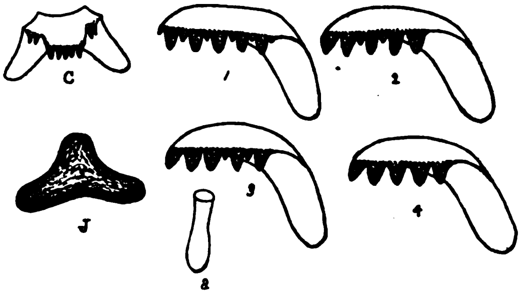

FIG. 111.

Radula and jaw of PHYSA GYRINA Say. (Original.) c, central tooth 1, 2, 3, 4, various types of principal marginal teeth; a, secondary teeth; J; jaw.

Habitat: Found very abundantly in ponds and streams of greater or lesser size, adhering to sticks or stones and crawling over the muddy bottom.

Remarks: This is a very common and handsome species. Its habits are active, moving with a rapid, steady, gliding motion. It is very interesting to watch a number of *Physæ* in an aquarium. As they are crawling along the bottom one will be seen to suddenly rise to the top of the water and move along with the foot applied to the surface, the shell hanging down. Again, they may be seen descending, suspended by a thin thread of mucus. When the animal rises suddenly, the branchial cavity opens with a faint clicking sound, probably due to the pressure of air in the lung. *Physa* frequently inhabits water as cold as the freezing point, and may be observed in winter gliding along the bottom of a pond when the surface is frozen. The eggs are deposited on stones, the under side of sticks, etc., and are composed of large, glairy, transparent masses.

Several *Physæ* kept in captivity laid four egg masses on April 23, 1897. These measured 20 by 4 mill., and contained from 130 to 200 eggs (one membrane 130, one 160 and one 200, Fig. 112). On April 24, ten additional egg masses were laid, the jar containing fifteen individuals. On June 3, in the afternoon, the writer noticed a number of young in a jar containing egg masses probably deposited in the latter part of April. The young were half a mill. in length, vitreous in appearance and perfectly transparent. They were very lively, crawling about the jar and eating voraciously. The heart pulsated one hundred and twenty times per minute. On June 15, the young had increased to 1 mill. in length. Unfortunately, about a week later the whole lot died, so no further notes could be taken.

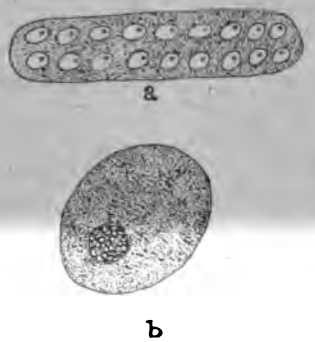

FIG. 112.

Egg-mass of PHYSA GYRINA Say. (Original.) a, egg-mass, showing position of eggs in envelope; b, single egg, much enlarged, showing position of rotating embryo.

Physa gyrina is by far the most common species of the genus (I might say of any genus) found in the area, and has been found in all parts of the region. It was at first confused with *heterostropha*, but that species has a smooth shell (see above) and is not found in any numbers in the area; it is very probable that *heterostropha* is not found west of the Mississippi River, and the quotations of this species from western localities were probably founded on *gyrina*, *sayii*, *gabbi*, *integra*, etc.

This species is very variable in this region, some forms approaching *ampullacea* Gould, while others might be taken for *gabbi* Tryon or *virginea* Gould, so far as form goes. It is probable that some west coast names will be added to the above synonymy, when more study has been given to this genus. This species is a triannuan.

127a. Physa gyrina var. **elliptica** Lea, pl. xxxiv, fig. 5.

Physa elliptica LEA, Trans. Amer. Phil. Soc., Vol. V, p. 115, pl. xix, fig. 83, 1837.
Physa aurea LEA, l. c., Vol. VI, p. 18, pl. xxiii, fig. 106, 1839.
Physa troostiana LEA, Proc. Amer. Phil. Soc., Vol. II, p. 32, 1841.
Physa nicklinii LEA, Proc. Phil. Acad. Sci., p. 114, 1864.
Physa altonensis LEA, l. c., p. 114, 1864.
Physa febigerii LEA, l. c., p. 114, 1864.
Physa oleacea TRYON, Amer. Journ. Conch., Vol. II, p. 6, pl. ii, fig. 6, 1866.
Physa elliptica minor CRANDALL, The Nautilus, Vol. XV, p. 55, 1901.

Shell: Differing from typical *gyrina* in being more elliptical, having a shorter, more rounded spire, and hence more convex whorls, the spire, as described by Tryon, "with the outline not elevated above a continuation of the general curve of the body." The shell is also more solid and the outer lip thicker, with a very heavy, bluish-white callus. The surface sculpture is the same as in *gyrina*.

Length, 15.00; width, 7.50; aperture length, 9.50; width, 3.50 mill. (8504.)
" 11.00; " 6.00; " " 7.00; " 2.50 " (8504.)
" 12.00; " 7.50; " " 9.00; " 3.75 " (8502.)

Animal, Jaw, and *Radula:* As in *gyrina*.

Distribution: Evidently the same as *gyrina*.

Geological distribution: Pleistocene; Loess.

Habitat: Almost always associated with *gyrina*.

Remarks: The typical form of this variety seems at first quite distinct from *gyrina*, but in a multitude of forms (the writer has examined several thousand specimens) is seen to fade imperceptibly into *gyrina*. From observations in the present area, *gyrina* would seem to be dimorphic, consisting of the typical *gyrina* with long spire and the variety *elliptica*, with short, dome-like spire. This belief is strengthened by the fact that the two forms are always associated together. It is not quite as common as the typical form.

128. Physa integra Haldeman, pl. xxxiv, fig. 6.

Physa integra HALDEMAN, Mon., p. 33, pl. iv, figs. 7, 8, 1841.

Shell: Oval, whorls four and one-half to five; spire short, pointed, the whorls convex; sutures well marked, sometimes bordered by a faint white line; color varying from light yellowish horn to pale brown; sculpture as in *gyrina*, the lines being very deep and the wrinkled ridges very convex; protoconch consisting of one and one-half smooth, rounded, wine-colored whorls; aperture oval, rather wide, produced at the anterior end, about two-thirds the length of the entire shell; peristome thin, thickened within the aperture by a heavy white or yellowish-white callus, which shows through the shell very plainly; it is never bordered by a color stripe; the callus of two or three former peristomes may always be seen on the body whorl and sometimes one or two on the spire; columella broad, flat, white, a callus spreading over the parietal wall.

Length, 12.00; width, 8.00; aperture length, 7.50; width, 3.00 mill. (12352.)
" 10.50; " 7.50; " " 7.50; " 3.50 " (12352.)
" 10.00; " 6.00; " " 5.50; " 3.00 " (12352.)

Animal: Not differing essentially from *gyrina*.

Jaw: Similar to that of *gyrina*.

Radula: Similar in form to that of *gyrina*, but differing in having six large, nearly equal cusps, instead of five, in the general absence of small cusps between the larger ones, and in the reflection being wider than in *gyrina* or *heterostropha*. The radula of this species is remarkably uniform in the form of the teeth and in the number of the cusps. The central tooth and secondary teeth appeared to be the same as in the species previously described.

Distribution: Great Lakes and St. Lawrence River; Indiana, Illinois, Tennessee, Michigan, and Wisconsin.

Geological distribution: Pleistocene.

Habitat: At stations similar to *gyrina*.

Remarks: This species has been generally confounded with *heterostropha*, but will at once be separated from that species by the spiral lines; the general form is also different from that of any shell found in this area, and the white callus on the lip is peculiar. It is a common shell at Hickory Creek, Lockport and Joliet, and has been found more sparingly at Calumet Grove, Maywood, and Edgewater. It is more common than *sayii*, but less so than *gyrina*. The specimens from Hickory Creek are quite typical, resembling closely Haldeman's figures (Pl. 4, Figs. 7, 8) in his monograph of fresh-water Mollusca. This species is a biannuan.

GENUS **APLEXA** Fleming, 1828.

Shell: Sinistral, narrow, elongated, thin, polished; spire long; aperture narrow, long; peristome acute; columella lip simple.

Animal: With a rather long foot, rounded before and pointed behind; mantle not reflected over the shell and with a simple edge; tentacles long and slender, eyes at their bases; genitalia?; jaw cartilaginous, arched, brown; radula with multicuspid central tooth and comb-like lateral teeth resembling those of *Physa.*

Distribution: Europe, North America, Northern Asia, Mediterranean region, West Indies, Oceanica.*

129. **Aplexa hypnorum** Linné, pl. xxxii, fig. 16.
Bulla hypnorum LINNÉ, Syst. Nat., p. 1185.
Physa elongata SAY, Journ. Phil. Acad., Vol. II, p. 171, 1821.
Physa glabra DE KAY, N. Y. Moll., p. 80, pl. V. fig. 83, 1843.
Physa elongatina LEWIS, Proc. Bost. Soc. Nat. Hist., Vol. V, pp. 122, 298, 1855.
Physa turrita J. DE C. SOWB., Fauna. Bor. Am., Vol. III, p. 315.
Bulinus tyroni CURRIER, Amer. Journ. Conch., Vol. III, p. 112, pl. vi, fig. 2, 1867. (?)

Shell: Very much elongated, thin, oblong; color yellowish-horn, with sometimes a zigzag, longitudinal band of bright yellow on the last whorl; apical whorls brownish, next blackish and last yellowish-horn; apex broadly round; surface polished, shining, diaphanous, growth lines numerous, but faint; whorls six, somewhat regularly increasing, flat-sided, convex; spire long, acutely conic; sutures but slightly impressed, margined; aperture elongate-ovate, narrow, contracted above, somewhat rounded below and somewhat expanded, occupying about half the length of the entire shell; peristome thin, sharp, rounded, no callosity on the inside; columella narrowed near the base, simple; no umbilicus; a view from the base of the shell shows a perforation (through the aperture) from the base, part way to apex.

Length, 15.00; width, 6.00; aperture length, 8.00; width, 2.75 mill. (8507.)
" 10.50; " 4.75; " " 5.50; " 2.25 " (8506.)
" 15.00; " 7.00; " " 7.50; " 3.50 " (12314.)
" 17.25; " 8.75; " " 8.50; " 3.50 "

Animal: With a rather wide foot, rounded before and pointed behind; head prominent, separated from the foot by a constriction, and auriculated; tentacles long and slender, tapering to a fine point, eyes placed on bulgings at their inner bases; head and neck distinguished from foot by a lateral constriction; color blackish, lighter on base and about the eyes and end of tentacles; mantle margin simple, not reflected over the shell. Genital orifice on left side.

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*Tryon, S. and S. Conch., Vol. III, p. 103.

Jaw: Not examined thoroughly, but apparently as in *Physa*, and cartilaginous, with no accessory plates.

Radula: With a central tooth as in *Physa* (?) excepting that it has the cusps differently arranged; teeth on either side serrated (comb-like) as in *Physa* (9-10 serrated), with a very long, pedunculated base of attachment, and without intermediate smaller serrations, as in *Physa.* The writer counted 78 teeth (39-1-39) in a single row and counted 230 rows in a membrane which was somewhat broken on the edges. The upper part of the pedunculated base has a peculiar lateral attachment in the form of a long, narrow projection. This membrane differs from *Physa* principally in lacking the small cusps between the longer ones and in the absence of secondary teeth. These peculiar lateral attachments may be the secondary teeth, but if so they are very long and narrow (Fig. 113).

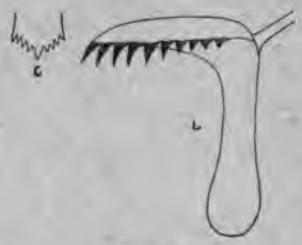

Fig. 113.

Radula of Aplexa hypnorum Linné. (Original.) c, cusp of central tooth; L, lateral teeth.

Genitalia: Not observed. Ova deposited without envelope.

Distribution: North America, Europe, Asia.

Geological distribution: Pleistocene.

Habitat: Found in the smaller rivers and lakes on a muddy bottom.

Remarks: A beautiful species, easily known by its long and narrow shell, which is highly polished. It has a strong resemblance to some forms of *Physa*, but may always be distinguished by the simple mantle margin of the animal. It is found in the three regions of the area, but is not common except in a very few localities.

Superorder Streptoneura.

In this group the nerves called the "visceral loop," being adherent to the body wall, shared in the torsion of the visceral hump, forming a figure-of-eight, the left cord crossing beneath the right. (Lankester.)

ORDER CTENOBRANCHIATA.

Animal breathing by a comb-like gill-plume (or ctenidium) which is situated on the right side of the body, the left ctenidium having become atrophied by the torsion of the visceral hump. The organs on the right side only are well developed. Sexes distinct.

SUBORDER STREPTODONTA.

Lingual membrane with curved teeth, generally broadly reflected.

Superfamily Tænioglossa..

Radula provided with numerous rows of teeth, with three laterals on either side of a central tooth (formula 3–1–3).

FAMILY PLEUROCERIDÆ.

Shell: Turreted, smooth or with rings and knobs; epidermis olivaceous; aperture channeled. Operculum paucispiral.

Animal: With a broad, short muzzle, which is not retractile; foot short, wide, angulated near the anterior end; mantle margin not fringed, plain; tentacles of medium size, cylindrical; eyes situated on short peduncles united to the outer sides of the tentacles; lingual membrane with 3–1–3 teeth, of which the central is wider than high, multicuspid, and the laterals are long and narrow and multicuspid. The first lateral is generally wider than the two outer teeth. The family is oviparous.

GENUS **PLEUROCERA** Rafinesque, 1819.

Shell: With a long and conical spire; aperture rather small, the outer lip produced into a canal about the middle; columella without callosity.

Animal: See under *P. subulare.*

Distribution: Ohio, Tennessee, Alabama, Illinois, Indiana, etc.

KEY TO SPECIES OF PLEUROCERA.

a. Last whorl rounded or subangulated; whorls rounded; aperture oval... *subulare*

b. Last whorl strongly carinated, whorls flat-sided, often heavily spirally striated; aperture triangular..................... *elevatum*

130. **Pleurocera subulare** Lea, pl. xxxv, figs. 1, 2.

Melania subularis LEA, Trans. Amer. Phil. Soc., Vol. IV, p. 100, pl. xv, fig. 30, 1834.

Shell: Smooth, elevated, acute, turreted; color pale brownish horn, with a yellowish band encircling the whorls just below the suture; there is sometimes an indication of a purplish band just above the periphery; apex rounded, smooth, horn-colored, bent in toward the whorls; surface shining, polished, lines of growth oblique, crowded, here and there more elevated than the average; sutures deeply impressed; whorls eleven, regularly increasing, the upper seven carinated just above the suture, the last four rounded; base of shell broadly conic, subangulated; imperforate; aperture ovate, narrowed above, white or bluish-white within, sometimes showing two spiral, brownish bands, produced and somewhat canaliculate below; peristome acute, sinuous, rather thick; columella bluish-white, twisted; terminations of peristome and columella joined by a thick, somewhat spreading callus. Operculum paucispiral, chestnut brown, the nucleus on the lower margin of the left side. The lines of growth rather coarse, showing under a lens that the operculum is made up of small plates or laminæ (Fig. 114).

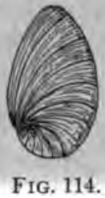

FIG. 114.
Operculum of PLEUROCERA SUBULARE Lea. (Original.)

Length, 22.00; width, 8.00; aperture length, 6.50; width, 4.00 mill. (9967.)
" 21.00; " 7.00; " " 7.00; " 3.50 " (9967.)
" 24.00; " 8.00; " " 7.00; " 4.00 " (9967.)
" 18.00; " 7.50; " " 7.00; " 4.00 " (9967.)
" 20.50; " 7.50; " " 7.00; " 4.25 " (9967.)

Animal: With a wide, short, thick foot, truncated before and rounded behind; color blackish above, yellowish underneath; there is a black patch on the top of the rostrum and about the eyes, and the sides of the foot and body are dark, mottled with light yellow; there is also a yellow band from the back of the eyes to the shell; mantle dark or blackish. Operculigerous lobe conspicuous; head prominent, with large, somewhat elongated rostrum, subconical in form, which projects far in advance of the foot, particularly when the animal is in motion; on the upper surface it is spirally wrinkled when the animal is at rest, but is almost smooth when the animal is in motion; the mouth is placed at the tip of the rostrum, which is disk-like, and is represented by a long, longitudinal slit, which makes the snout-end look like a double disk; the radula may be plainly seen in the mouth when the animal is feeding; tentacles of medium length, somewhat tapering; eyes black, placed on prominences at the outer bases of the tentacles. Mantle simple, folded on the right side to form the respiratory cavity. Generative duct on right side, opening at the junction of back with mantle, the duct is composed of two laminæ placed close together; anus placed above the generative duct. The gills (branchiæ) are two in number, placed, as usual, upon the under side of the mantle, and are composed of a primary (comb-like) and secondary (feather-like) gill; the former being very long and gradually narrows toward the posterior end, and the latter very simple and running parallel with the primary gill, and composed of a midrib, with bare indications of the "feathers." In one specimen the foot measured 6.00 mill. in length and 3.50 mill. in width.*

Jaw: Elongately ovate, the surface covered with numerous small, rounded or polygonal scales.

Radula formula: $\frac{1}{10}+\frac{1}{8}+\frac{1}{5}+\frac{1}{7}+\frac{1}{5}+\frac{1}{8}+\frac{1}{10}$ (3—1—3); central tooth with a low, wide base of attachment, the reflected portion seven-dentate, the central cusp very large, side cusps very much smaller; intermediate tooth almost square, five-dentate, the inner cusp small, the next cusp very large and the three outer side cusps small; lateral teeth more or less sole-shaped, longer than wide, the first eight- and the last ten-dentate; the outermost lateral flares a little at the upper part. In one membrane the writer counted 43 rows of teeth. The teeth are in all respects like those of *P. elevatum.*

Genitalia: Not examined thoroughly. The sexes are distinct, but there is a total absence of copulatory organ in the male. In the present species there is a peculiar sinus in the female, on the right side of the foot, between the operculigerous lobe and tentacle; the male is without this sinus. The only way to be absolutely sure of the sexes is to crush the body and examine with a microscope, when, if a male, spermatozoa will be found, and, if a female, ova will be found.

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*The writer has been very materially assisted in making the anatomical examinations of this group by an article by Dr. William Stimpson, in Amer. Journ. Sci. and Arts, 2nd series, Vol. XXXVIII, p. 41, 1864.

Distribution: New York to Great Lakes, south to Ohio River drainage.

Geological distribution: Pleistocene.

Habitat: Found generally on a sandy or rocky bottom in shallow water, where there is little or no current.

Remarks: This species is subject to no little variation in its obesity and ornamentation; the typical form is almost smooth but the variety *intensum* is more strongly keeled on the periphery and has several additional spiral lines. It is separated from *P. elevatum* by its more rounded whorls, particularly the last, and by its aperture, which is oval instead of triangular. The animal is slow and very sluggish in movement, and in an aquarium spends most of the time on the bottom of the tank, with its body half protruding from its shell and with its rostrum and tentacles slowly moving about. The species seems to be confined to the southern region and has thus far been found only in Wolf Lake.

130a. Pleurocera subulare intensum Anthony, pl. xxxv, fig. 3.
Melania intensum ANTHONY, REEVE, Monog. sp. 371.

Shell: Differing from the typical form in being of a much darker greenish-horn color, and in having the carina above the suture extending in a more prominent manner to the base of the last whorl. There are also seven subobsolete spiral lines, especially on the base, which are not developed in ***subulare.***

Length, 24.00; width, 8.00; aperture length, 7.00; width, 4.50 mill. (8735.)

Animal, Dentition, etc.: As in *subulare.*

Distribution and *Habitat:* As in *subulare.* (?)

Remarks: The variety does not seem to be as common as the typical form and has been found only in the Desplaines River. It approaches *elevatum* in form, particularly when there is a decided keel on the periphery.

131. Pleurocera elevatum Say, pl. xxxv, fig. 4.
Melania elevata SAY, Journ. Phil. Acad., Vol. II, p. 176, 1821.
Melania tracta ANTHONY, Proc. Bost. Soc. Nat. Hist., Vol. III, p. 361, 1850.

Melania elongata LEA, Trans. Amer. Phil. Soc., Vol. IV, p. 121, pl. xv, fig. 29, 1834.

Shell: Elevated, acute, turreted on the upper whorls; color yellowish-horn, olivaceous or greenish-horn, encircled by a yellow band just below the suture, and with two purplish bands encircling the whorls just above and below a line drawn about the center of the whorl; apex sharp; surface shining and polished, encircled by from three to five fine spiral raised lines, of which the lower one is the larger, situated just above the suture, giving the shell a carinated aspect; this carina is especially noted at the periphery; the base of the shell is encircled by five spiral ridges of greater or lesser prominence; lines of growth numerous, crowded, oblique, giving the surface a wrinkled aspect; sutures impressed; whorls ten to eleven, flat sided, regularly increasing, the upper ones doubly carinated and the lower ones with a single carina, although in some examples the carina almost disappears on the lower whorls; spire very long, long-conic; base of shell broadly conic, angulated, imperforate; aperture obliquely triangulate, produced at the lower part into a short spout; yellowish-horn within, with a broad, reddish-brown band encircling the base near the columella and descending the spout-like projection in the lower part of the aperture, with another band near the center; peristome thin, sharp, simple, sinuous; columella thickened by a heavy white callus which is reflected over the columellar region and columellar lip. Operculum similar to that of *subulare.*

Length,	21.00;	width,	8.00;	aperture length,	8.00;	width,	4.00	mill.	(8743.)
"	22.00;	"	8.50;	" "	7.50;	"	4.00	"	(8740.)
"	31.00;	"	12.00;	" "	8.00;	"	4.00	"	(8743.)
"	39.00;	"	12.00;	" "	10.00;	"	5.50	"	(9963.)
"	24.50;	"	9.50;	" "	9.50;	"	4.50	"	(9966.)

Animal: Similar in general form to *subulare;* color yellowish, streaked with black on top of rostrum and foot; the rostrum is rather long and much roughened by spiral ridges; foot wide, short and whitish beneath; eyes placed on swellings on the upper surface of the base of the tentacles. The specimens examined were mostly females, with the lateral sinus very prominent.

Jaw: As in *subulare.*

Radula formula: $\frac{1}{11}+{}_{7}\frac{1}{-}{}_{9}+\frac{1}{7}+{}_{3-}\frac{1}{1}{}_{-3}+\frac{1}{7}+{}_{7}\frac{1}{-}{}_{9}+\frac{1}{11}$ (3—1—3); teeth generally as in *subulare;* the intermediate tooth has five outer cusps instead of three, as in *subulare;* the inner lateral has seven to nine cusps, all large, and the outer lateral has eleven small cusps. All the teeth seemed to have well developed cutting points (Fig. 115, Mus. no. 12770).

Genitalia: Not examined, but external appearance as in *subulare.*

Distribution: Lake Michigan, Ohio, Indiana, Illinois, Kentucky, Tennessee.

Geological distribution: Pleistocene; Loess.

Habitat: Found in rivers and ponds, in more or less clear water, on a sandy bottom. Does not like a muddy habitat.

Remarks: This species is distinguished from *subulare* by its very pronounced peripheral carina and flat-sided whorls. It also attains a much larger size. When browsing on the glass side of an aquarium, *elevatum* thrusts out its rostrum to its fullest length, the tentacles are drooped and it slowly proceeds in this manner, the radula being plainly seen in action at the end of the rostrum. This species does not seem to be as common in individuals as *subulare.* It has been found fossil in a cellar on the corner of Sheffield and Lincoln avenues.

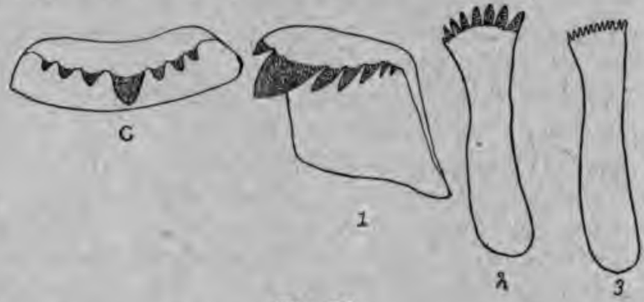

FIG. 115.

Radula of PLEUROCERA ELEVATUM Say. (Original.) C, central tooth; 1, intermediate tooth; 2, 3, lateral teeth.

131a. Pleurocera elevatum lewisii Lea, pl. xxxv, figs. 5-6.

Trypanostoma Lewisii LEA, Proc. Phil. Acad., p. 172, 1862.

Shell: Differing from the typical form in being strongly striate, the striæ being raised into heavy ridges. The form is also heavily banded with brown, and the satures are strongly impressed.

Length, 27.50; width, 10.00; aperture length, 8.00; width, 5.00 mill. (8745.)
" 27.00; " 9.00; " " 8.00; " 4.50 " (8745.)
" 39.00; " 15.00; " " 12.50; " 7.50 " (12312.)
" 27.00; " 13.00; " " 11.00; " 6.00 " (12312.)

Animal, *Radula*, etc.: As in the typical form.

Distribution: As in the type.

Remarks: This variety does not seem to be as common as the typical form. It is connected with *elevatum* by almost imperceptible degrees, and is simply a striate form, but is worthy of varietal distinction. It is found in the southern and western regions.

GENUS GONIOBASIS Lea, 1862.

Elimia[*] H. & A. ADAMS, Genera, Vol. I, p. 300, 1854.
Goniobasis LEA, Proc. Phil. Acad. Sci., p. 262, 1862.

Shell: Generally elongated, spire long and more or less pointed; aperture produced in front, but not canaliculate or notched.

Animal: Resembling that of *Pleurocera;* jaw and radula same as in the last genus.

Distribution: Entire United States.

132. **Goniobasis livescens** Menke, pl. xxxv, fig. 7.
Melania livescens MENKE, Syn. Meth., p. 135, 1830.
Melania niagarensis LEA, Proc. Amer. Phil. Soc., Vol. II, p. 12, 1841.
Melania napella ANTHONY, Proc. Bost. Soc., Vol. III, p. 362, 1850.
Melania cuspidata ANTHONY, l. c., p. 362, 1850.
Melania correcta BROT., List, p. 39.
Goniobasis milesii LEA, Proc. Phil. Acad., p. 154, 1863.
Goniobasis translucens ANTHONY, Amer. Journ. Conch., Vol. I, p. 36, pl. i, figs. 1, 2, 1865.

Shell: Varying from elongate to ovate, acuminate, frequently turreted on the upper whorls; color varying from bluish flesh to light corneous, sometimes greenish, and frequently with two dark brown bands; apex sharp, rounded, turned downwards; surface shining, with no spiral lines save a carina which encircles the center of all the whorls but the last two, and is obsolete in the more bulbous forms; lines of growth oblique, wrinkled, crowded; satures well impressed; whorls seven to nine, more or less rounded, regularly and rapidly increasing in size, the upper whorls carinated; spire elevated, either sharp-conic or obtuse-conic; aperture large, ovate or subrhomboidal, produced at the lower part, brownish-purple to purple inside; peristome sharp, thin on the edge, but thickened by a callosity within the outer lip, more or less sinuate; columella thick, solid, tinged with blue or purple, and reflected over the columellar region and columellar lip; last whorl usually very convex, inclined to bulbous. Operculum not essentially different from that of *Pleurocera*.

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[*] In the first pages of this work the writer used *Elimia* for this well-known group of mollusks, following Mr. Pilsbry's suggestion (Proc. Phil. Acad., p. 496; 1896); after these pages were in print Mr. Pilsbry, in a letter, again suggested that it was very probable that *Elimia* would not stand after all, being but a heterogeneous assembly of different forms, in the presence of Lea's excellent and well-characterized diagnosis.

Length,	16.50;	width,	7.00;	aperture	length,	6.50;	width,	3.50	mill.	(8748.)
"	18.00;	"	7.50;	"	"	7.00;	"	4.00	"	(8748.)
"	12.00;	"	6.00;	"	"	6.00;	"	3.00	"	(8748.)
"	11.00;	"	6.00;	"	"	6.00;	"	3.50	"	(8748.)
"	13.00;	"	6.00;	"	"	5.50;	"	3.00	"	(8748.)
"	15.50;	"	7.00;	"	"	7.00;	"	4.00	"	(8746.)
"	20.00;	"	9.50;	"	"	9.00;	"	5.00	"	(12369.)

Animal: Similar to *Pleurocera* in form; color bluish-white on base of foot and sides; body yellowish, darker in places; rostrum blackish on middle portion, yellowish at the tip; neck yellowish; the rostrum is not as heavy as in the last genus. There seems to be little generic difference between the animals of these two genera.

Jaw: Like that of *Pleurocera*.

Radula formula: $\frac{1}{10}+\frac{1}{8}+\frac{1}{5}+\frac{1}{9}+\frac{1}{5}+\frac{1}{8}+\frac{1}{10}$ (3—1—3); the teeth are similar to those of *Pleurocera subulare*, excepting that the central tooth has four small cusps on each side of the central cusp; the cusps are a little rounder in the present species than in the one mentioned.

Genitalia: Not observed.

Distribution: New York to Great Lakes, south to Ohio River drainage.

Geological distribution: Pleistocene; Loess.

Habitat: Found rather plentifully on a muddy (sometimes sandy) bottom, in water from two to ten or more feet in depth. Prefers a bottom with water weeds.

Remarks: A very distant species, at once known by its bulbous form, convex outer lip and bluish or purplish aperture and columella. The spire is very broadly conic. *G. milesii* is simply a smooth, extra bulbous form of *livescens*, not entitled to even varietal rank. There is considerable variation in the carination of the upper whorls, but all of these different forms may be connected with the type by a series of specimens. The individuals from Lake Michigan are always heavier and more solid than those from the smaller lakes and rivers.

The animal moves slowly, pushing its foot forward a short distance and then drawing the shell after it. This is particularly noticeable when crawling up the side of a glass jar.

While moving about, the rostrum is kept constantly in motion, as well as the long, filiform tentacles, and the lingual apparatus may be distinctly seen, as in *Limnæa*, the mouth being a long, vertical slit in the end of the rostrum. The animal frequently comes to the top of the water and, pushing its rostrum above the surface, will remain in this way for hours.

Livescens has been found in a fossil state on Balmoral avenue, north of Bowmanville, on the corner of Sheffield and Lincoln avenues, and in sand banks on the lake shore, north of Graceland avenue.

132a. **Goniobasis livescens depygis** Say, pl. xxxv, fig. 8.
Melania depygis SAY, New Harm. Dissem., p. 291.
Melania occulta ANTHONY, Proc. Phil. Acad., p. 5, 1860.

Shell: Differing from typical *livescens* in being narrower, the two color bands brighter and more conspicuous and the columella not tinged with purple.

Length.	Width.	Aperture Length.	Width.
23.00	8.50	9.00	4.50 mill. (coll. Ferriss.)
17.25	7.75	8.00	4.50 " (coll. Ferriss.)

Animal, Jaw and *Dentition:* As in *livescens.*

Genitalia: Not observed.

Distribution: Same as *livescens.*

Geological distribution: Pleistocene; Loess.

Habitat: Same as *livescens.*

Remarks: After the examination of several thousand specimens from Northern Illinois, and after consulting with several conchologists, it seems imperative that *depygis* must become a variety of *livescens*, and it is an open question if it is entitled to even varietal rank. The writer has before him a set of *Goniobasis* in which there is a perfect gradation from the heavy, swollen *livescens*, with dark shell and purple tinged columella, to the most graceful *depygis*, with light shell and dark spiral bands, and white columella. The variety has been found only at Hickory Creek.

FAMILY AMNICOLIDÆ.

"Tentacles elongated, with eyes at their outer bases. Operculum subspiral or concentric. Shell small, globular or elongated, spiral. Aperture broadly oval, lip continuous. Generally umbilicated."*

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*Tryon, continuation of Haldeman's monograph, No. 1, p. 8.

"Lingual teeth 3–1–3; the rows being more transverse and less arcuated than in the *Littorinidæ*. Rhachidian tooth broader than long, and armed with basal denticles (so-called by Troschel) on each side, which may be either on the basal margin, or on the anterior surface of the tooth above the base; cusp recurved and denticulated. Intermediate tooth more or less hatchet-shaped, having a handle-like process (peduncle) projecting outwardly from the base of the broad body which is denticulated at the upper margin. Lateral teeth generally slender and armed with numerous minute denticles at their superior margins. Verge (male organ) exserted, situated on the back at a considerable distance behind the right tentacle. Gills both pallial; the right or principal one usually rather short and broad, and composed of few laminæ, which are much broader than high. Foot oblong, truncate before, rounded or pointed behind. Operculigerous lobe well developed." (Stimpson.)* "Inhabits fresh water in all parts of the world." (Tryon.)

Subfamily Bythiniinæ.

"Shell small, conical; peristome simple or thickened. Operculum calcareous or concentric. Fresh water." (Tryon.)†

GENUS BYTHINIA Gray.

"*Shell:* Oval, turbinated, thin, invested with a thin epidermis, peritreme continuous." (Tryon.)

133. **Bythinia tentaculata** Linné, pl. xxx, fig. 34.
Turbo tentaculata LINNE, Syst. Nat. Ed. XII, p. 1249.

Shell: Globose, rather thick, transparent to opaque; color ranging from yellowish to greenish, sometimes brownish; surface shining, smooth, lines of growth very fine; sutures very deeply impressed; whorls five, convex, the last rapidly enlarging and equaling all the others combined; spire elevated, broadly conic; apex small, round, reddish-brown; aperture broadly rounded-ovate, narrowed above; pe[illegible] rounded, simple, continuous, thickened a litt[illegible] bordered all around with yellowish; base [illegible] imperforate.

Length,	9.50;	width,	6.00;	Aperture,	length,	[illegible];	width,
"	11.00;	"	6.50;	"	"	4.[illegible]	"
"	9.00;	"	6.00;	"	"	[illegible]	

---

*Binney's Land and Fresh W[illegible]

†[illegible]s. and S. Conch., Vol. II, p. [illegible]

Animal: Color yellowish-white on foot and body; head and rostrum black with several yellow or golden-yellow spots, the tip of the rostrum yellowish-white. Rostrum rather large, rounded. Tentacles long and filiform, the black eyes placed on swellings at their lower outer base. The body appears speckled with black and yellowish-white through the shell. Foot wide, rather short, slightly auriculated before, whitish on edge with a yellowish part near the center and toward the anterior end. Cervical lobes (lappets) round, wide, short, rather fully extended. Verge rather large, placed as usual in the family. Operculum placed toward the posterior part of the foot, calcareous within, concentric; the rings of growth stand up in the form of ridges or scales, and their arrangement is quite regular (Fig. 116). The foot measures 6.50 mill. in length and 4.00 mill. in width.

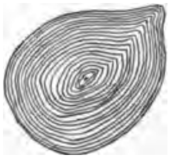

FIG. 116.
Operculum of BYTHINIA TENTACULATA Linné. (Original.) Enlarged.

Radula formula: $\frac{1}{16}+\frac{1}{12}+\frac{1}{7}+\frac{7}{6+6}+\frac{1}{7}+\frac{1}{12}+\frac{1}{16}$ (3 − 1 − 3); central tooth wider than high, ends produced and rounded, lower edge concave and with a rounded process extending from its center; lateral lobes armed with six to seven denticles

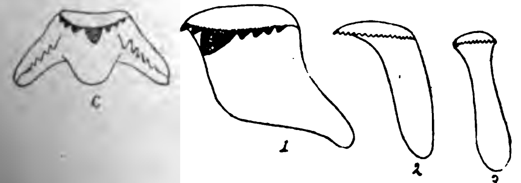

FIG. 117.
of BYTHINIA TENTACULATA Linné. (Original.) C. central
mediate tooth; 2, 3, lateral teeth.

ather long and roundly pointed, the denticulate
ding from just beneath the reflection to the end
flection wide and low, seven-cuspid, the center
undly pointed and the lateral cusps sharply
tooth squarish, the lower outer corner
nd low, seven-cuspid, the third cusp

from the left very large and roundly triangular, the side cusps, two on the left and four on the right, sharply triangular; lateral teeth long and narrow, the lower ends rounded, the reflections very wide and low, the first twelve-cuspid and the second sixteen-cuspid (Fig. 117).

Distribution: Europe and America (the latter introduced), New York, Ohio, Illinois, Michigan, Wisconsin.

Geological distribution: Pleistocene.

Habitat: In the larger lakes, on a sandy or muddy bottom, and attached to sticks, stones, and other submerged objects.

Remarks: This is the largest species of *Amnicolidæ* found in this region. It may be easily distinguished by the size of the last whorl, which more than equals in length that of all the rest. The species was introduced into this country many years ago and is now found from Vermont and New York to Wisconsin. It is particularly abundant in Lake Michigan. While in motion the animal of *Bythinia* is rather slow, the tentacles move about nervously and the rostrum is thrust out to its fullest extent. Thus far it has been collected only in Lake Michigan.

Recently the Lake View water supply has been seriously threatened by the presence of this snail. The small service pipes became choked and in many private houses a tumblerful of these animals was taken from the faucet. Investigation at the Lake View crib showed that the screens were provided with such a large mesh that the eggs gained access to the main tunnel and there developed, the force of the water drawing them farther and farther into the tunnel until they finally appeared in the service pipes. Besides this species, *Pleurocera elevatum* and *Goniobasis livescens* were found about the crib, but none on the inside. These were collected in August, 1898.

Subfamily Hydrobiinæ.

Shell: Small, elongated or globose, umbilicated or rimate; aperture rounded or ovate; peristome continuous; operculum paucispiral, corneous (Tryon), without internal process. Foot without lateral sinuses. (Stimpson.)

GENUS **AMNICOLA** Gould and Haldeman.

Shell: Small, thin, smooth, globose, umbilicated; spire broadly conic; aperture broadly ovate; outer lip thin; operculum subspiral, corneous.

Animal: With a short, broad foot which is broadly rounded behind; rostrum short; tentacles cylindrical, blunt at their tips; verge short, bifid, with a globular base; jaw present; lingual dentition of *A. porata;* rhachidian tooth very short and broad, with a tongue-shaped process from the middle of the anterior surface, reaching beyond the base; intermediate tooth with a short, broad body having a strongly projecting infero-interior angle, and a very long peduncle; formula of denticles: rhachidian, ${}_{4}\overset{7}{-}{}_{4}$; intermediate, five; first lateral eighteen; second lateral thirty. (Stimpson.)*

"Ova-capsules semilenticular in form, with a lamniform limb. Each contains but one egg." (Stimpson.)*

Distribution: North America.

KEY TO SPECIES OF AMNICOLA.

- A. Shell 5 mill. or over in length, whorls swollen, spire somewhat elongated.................................... *cincinnatiensis*
- B. Shell 4 mill. or less in length.
  - a. Shell swollen, diameter and length about equal............ *limosa*
  - b. Shell narrow, diameter about half of length.
    - 1. Spire obtuse, whorls four.......................... *emarginata*
    - 2. Spire pointed, whorls five........................... *lustrica*

134. **Amnicola limosa** Say, pl. xxx, fig. 35.

Paludina limosa SAY, Journ. Phil. Acad., Vol. I, p. 125, 1817.
Amnicola schrokingeri FRAUENFELD, Pric. Zoöl. Bot. Gesell, Vienna.
Amnicola ferruginea CALKINS, Valley Naturalist, Vol. II, No. I, p. 6, 1880.

Shell: Conic, bulbous, subimperforate, nearly as broad as high; color light or dark brown, without bands of color; surface shining (except when covered by deposit of foreign matter, as is frequently the case), lines of growth numerous, fine, wrinkled, crowded; sutures well impressed; whorls four to five, more or less inflated, regularly increasing; spire obtusely conic, swollen; aperture orbicularly ovate, rounded above and below, dark horn-color within; peristome sharp, simple, a little thickened on the inside, almost continuous; columella lip covered with a thin callus; base of shell rounded, subumbilicate.

Length, 5.00; width, 3.25; aperture length, 2.10; width, 1.50 mill. (10498.)
" 5.00; " 4.00; " " 2.60; " 2.10 "
" 5.00; " 4.00; " " 2.80; " 2.10 " (13052.)

Animal: White and transparent, brownish on the head; foot short, rather wide, about two and one-half times as long as broad, auriculated before, rounded behind and constricted in the center; operculigerous lobe oval, broader than the foot; operculum horny, thin, subspiral, striated spirally and longitudinally, except on the older part which is striate spirally (Fig. 118, 1); rostrum short, broad, emarginate in the middle; tentacles long and slender, cylindrical, blunt; eyes placed at the inner base of the tentacles, in front of a prominent tubercle; mantle simple on the edge; verge placed on the right side of the back, behind the right tentacle, bifid, one part being short, thick and truncated at the extremity, and the other long, pointed, and partly coiled about the first, generative organ in the female generally found "at the junction of the body with the mantle, a short distance within the margin of the latter"* (Fig. 119).

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*Binney, l. c., p. 80-81.

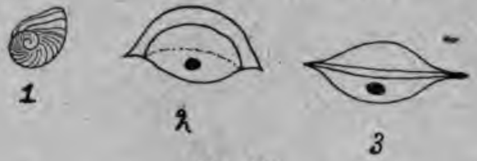

FIG. 118.
AMNICOLA LIMOSA Say. (1, Binney, Fig. 159; 2, 3, Stimpson, Fig. 7.) 1, operculum; 2, 3, egg-capsule, dorsal and side views. (Enlarged.)

"The ova are deposited, in this latitude, during the months of April and May. The ova-capsule is thin, corneous, of a semilenticular shape, and attached by the cut face of the lens, which forms the base. The free limb is margined with a broad, thin lamina of the same delicate, horny texture as the envelope of the capsule itself. In size these ova-capsules are a little larger than the head of the animal. They are deposited singly and each contains but a single egg, which floats freely

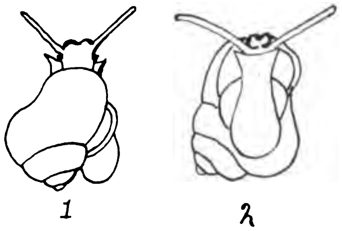

FIG. 119.
Animal of AMNICOLA LIMOSA Say. Enlarged. (Stimpson, Figs. 1 and 2.) 1, dorsal view; 2, ventral view.

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*The writer must acknowledge his indebtedness to the splendid work of Dr. William Stimpson (Researches upon the Hydrobiinæ, etc.), from whose pages much information has been gleaned. (See pp. 13-16).

about in the fluid surrounding it. Those which occurred to me were found sticking to the shell of a female, although they were probably not deposited by the same individual but by some other, as they were huddled together in groups according to their practice at this season."* (,Fig. 118, 2, 3).

Radula formula: $\frac{1}{30}+\frac{1}{18}+\frac{1}{5}+\frac{7}{4+4}+\frac{1}{5}+\frac{1}{18}+\frac{1}{30}$ (3—1—3); rhachidian (central) tooth very wide, low, the ends much rounded and produced, lower edge concave; center of concave portion supporting a large, tongue-shaped process; ends supporting, upon the anterior surface, four denticles, the two center ones small and the outer ones larger; the ridge supporting the denticles extending from the distal end of the lateral lobe almost to the reflected cusp; reflection small, seven-cuspid, the cusps very small except the center one, which is rather large; intermediate tooth subquadrate, the peduncle very long and somewhat enlarged at the distal end; body of tooth, at the inner side, with a peculiar knob-shaped projection; reflection low, wide, five-cuspid, the cusps subequal; inner cusp bluntly rounded, the rest acute; lateral teeth very long and narrow, the reflections small and multicuspid, the first having eighteen and the second thirty cusps (Fig. 120).

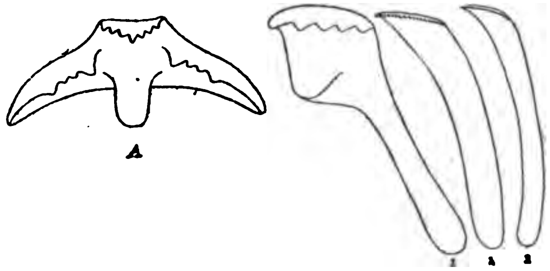

FIG. 120.

Radula of AMNICOLA LIMOSA Say. (From nature, after Stimpson.) A, central tooth; 2, 3, lateral teeth.

Distribution: New England to Utah and Manitoba, Hudson's Bay to Texas.

Geological distribution: Pleistocene; Loess.

Habitat: Found plentifully in lakes and streams, on the muddy bottom, or on aquatic plants and submerged objects.

Remarks: This abundant little species is easily recognized by its globose form. The animal is very interesting in captivity and wanders rapidly about the aquarium with a wabbly gait. It is widely distributed throughout the area. At several points in Chicago it has been found among Pleistocene fossils.

134a. Amnicola limosa parva Lea, pl. xxxi, fig. 11.

Amnicola parva LEA, Proc. Amer. Phil. Soc., Vol. II, p. 34, 1841; TRYON, Con. Haldeman's Monograph, pl. xvii, fig. 2.

Shell: Smaller than typical *limosa*, the whorls shouldered and tumid below the suture. Otherwise like *limosa*.

Length, 3.50; width, 2.75; aperture length, 2.00; width, 1.50 mill. (10218.)
" 3.25; " 2.00; " " 1.50; " 1.25 " (10218.)

Animal and *Dentition:* Same as *limosa*.

Distribution: Atlantic and Middle States.

Geological distribution: Pleistocene.

Habitat: Same as *limosa*.

Remarks: This form is found at Joliet, Salt Creek and Berry Lake; the writer has admitted it to varietal rank for the reason that it seems to be always recognizable, although it is apparently only a stunted form of *limosa*. It is not common.

134b. Amnicola limosa porata Say, pl. xxvi, fig. 13.

Paludina porata SAY, Journ. Phil. Acad., Vol. II, p. 174, 1821.

Amnicola orbiculata LEA, Proc. Amer. Phil. Soc., Vol. II, p. 34, 1841.

Shell differing from *limosa* in being generally widely umbilicated, in the whorls being more swollen and the spire shorter.

Length, 5.00; width, 4.00; aperture length, 2.80; width, 2.10 (13357.)
" 5.00; " 4.50; " " 2.80; " 2.05 (13357.)

This variety is the most common and is universally distributed.

135. Amnicola lustrica Pilsbry, pl. xxvi, fig. 12.

Amnicola lustrica PILSBRY, The Nautilus, Vol. IV, p. 53, 1890 (not *A. lustrica* SAY—*Pomatiopsis lapidaria* SAY).

Shell: Narrow (for the genus), thin, translucent; color waxy, light brownish or greenish; surface smooth and shining, lines of growth very fine, but distinct when viewed with a lens; sutures very deeply impressed; spire elevated, conical; whorls five, rounded, regularly increasing in size; aperture roundly ovate, slightly angled above, waxy inside; peristome continuous, thin, appressed to the body whorl only for a short distance near the upper terminations; base broadly rounded, with a n[illegible] and deep umbilicus. Oper[illegible] [illegible]ilar to that of *A*[illegible]

Length, 4.00; width, 2.00; aperture length, 1.50; width, 1.10 mill. (10497.)

Animal and *Radula:* Similar to *A. limosa.*

Distribution: New York to Illinois and Minnesota. (Pilsbry.)

Geological distribution: Pleistocene.

Habitat: Same as *A. limosa.*

Remarks: This species is distinguished from all others of the genus by its narrow, elongated whorls and rather acute spire. It is said by Mr. Pilsbry to be the narrowest of the genus. *Lustrica* does not seem to be at all common and has only been found at Berry Lake and Joliet.

SUBGENUS **CINCINNATIA**, Pilsbry, 1891.

Proc. Phil. Acad., p. 327, 1891.

Radula more minute and denticulations finer than in the typical form.

136. **Amnicola cincinnatiensis** Lea, pl. xxvi, fig. 14.

Cyclostoma cincinnatiensis LEA, Proc. Amer. Phil. Soc., I, p. 289, 1840; Trans. Amer. Phil. Soc., VIII, p. 229, pl. vi, fig. 62, 1843.

Amnicola sayana ANTHONY, in HALDEMAN, Mon., p. 19, pl. i, fig. 4, 1844? (Figs. 4 and 11 are misnamed in Haldeman; 4 is the present species and 11 is *Pomatiopsis cincinnatiensis* Anthony.)

Shell: Of good size, swollen, umbilicated, rather solid; color ranging from greenish to yellowish-brown, translucent; surface smooth and shining, lines of growth well developed, crowded; sutures forming deep channels between the whorls; apex small, rounded, smooth, brownish; spire broadly conic, elevated; whorls five to six, rapidly increasing, swollen, rounded, the last somewhat loosely coiled so that the aperture is continuous and separated from the body-whorl; aperture roundly ovate, bluish-white within; peristome continuous, simple, thin, sharp, appressed to the body-whorl only at the upper part; base rounded, with a small, rounded umbilicus of great depth.

Length, 5.00; width, 4.00; aperture length, 2.00; width, 1.75 mill. (10653.)
" 5.50; " 4.00; " " 2.00; " 1.75 " (10653.)

Animal: Yellowish-white above, whiter on base of foot; subtransparent; foot short and wide, auriculated before, rounded behind and constricted in the center; operculigerous lobe and operculum as in *limosa;* rostrum short; tentacles long and slender, blunt; eyes, mantle and verge as in *limosa.*

Radula formula: $\frac{1}{18}+\frac{1}{13}+\frac{1}{5}+\frac{7}{3+3}+\frac{1}{5}+\frac{1}{13}+\frac{1}{18}$ (3 − 1 − 3); [illegible]s. No. 12769); central tooth similar to that of *limosa*, but ends supporting only two denticles, and a bulge near the lower end; process on concave margin large; intermediate tooth of the usual shape, but the denticles longer and narrower than in *limosa* and the central denticle rounded and blunt, the others sharp; inner and outer lateral teeth denticulated as in *limosa* (Fig. 121). The figure of this species in Binney's "Land and Fresh Water Shells" (Fig. 162), taken from Troschel, must be an error, for it does not at all correspond with the specimens examined by the writer, which are undoubted *cincinnatiensis*. The species is peculiar in having the cusps of the intermediate tooth long and sharp, and in the central cusp being wide and blunt. The figure in Binney's is probably the radula of some *Pomatiopsis*, perhaps *P. lapidaria*.*

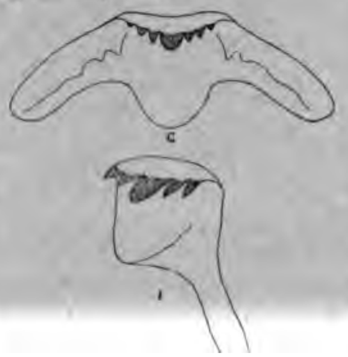

FIG. 121.

Radula of AMNICOLA CINCINNATIENSIS Lea. (Original.) C, central tooth; I, intermediate tooth.

Distribution. New York to Utah, south to Texas.

Geological distribution: Pleistocene.

Habitat: Same as *limosa*

Remarks: This is the largest species of *Amnicola* found in this region and attains a length of five or six mill. Its large size, swollen whorls, and elevated conic spire will at once distinguish it from related species. It is rather common, especially at Joliet, where it is the prevailing species.

137. Amnicola emarginata Küster, pl. xxvi, fig. 10.

Paludina obtusa LEA, Proc. Amer. Phil. Soc., Vol. II, p. 34, 1841, non Troschel, 1837.

Paludina emarginata KÜSTER, Paludina, Conch. Cab., p. 50, pl. x, figs. 3, 4, 1852.

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*It should be noted here that the present figure is drawn to a larger scale than that of the radula of *Amnicola limosa*. The radula of *A. cincinnatiensis* is smaller and the denticulations are smaller, narrower and sharper than in *A. limosa*.

Amnicola cincinnatiensis BINNEY, L. and F. W. Sh., N. A., p. 85, fig. 169, 1863.

Shell: Small, globose, rather solid; color, different shades of green; surface smooth, polished, lines of growth very faint; sutures well marked; apex very obtuse, comprising one and one-half whorls; when viewed from the front the shell appears to have a truncated spire; spire very broadly truncate-conic; whorls four to four and one-half, very convex; aperture nearly round, appressed to the body-whorl; peristome continuous, rather thick, simple; base rounded, with a small umbilicus.

Length, 4.00; width, 2.00; aperture length, 1.50; width, 1.10; mill. (10241.)
" 3.25; " 1.75; " " 1.50; " 1.10; " (10241.)

Animal: Not examined.

Radula: Not examined.

Distribution: New York west to Iowa and Winnipeg, Canada, south to Kentucky.

Geological distribution: Pleistocene.

Habitat: In rivers and ponds, on a muddy bottom.

Remarks: This species at first sight might be taken for *A. lustrica*, but the spire is very *obtuse*, while that of *lustrica* is *acute*, and the last whorl is appressed to the body-whorl, at the aperture in *obtusa*, while in *lustrica* it is entirely free. The species seems to be very rare, and living specimens have been found only in the DuPage River. It has been collected on the recent beach in a subfossil condition. Several dead specimens were obtained in the North Branch of the Chicago River and in beach drift at Miller's, Ind.

GENUS **PALUDESTRINA** Orbigny.

Bythinella Moquin-Tandon.

Shell: Small, elongately-ovate, smooth and shining, with an elevated spire; sometimes decidedly pupiform, rimate or imperforate; apex generally obtuse; aperture ovately-rounded; peristome continuous, outer lip thickened. Operculum corneous, the nucleus large and placed rather near the basal margin.

Animal: With a narrow foot which is rounded behind; tentacles tapering to a blunt tip; verge bifid; lingual dentition (of *B. nickliniana*); rhachidian tooth nearly as wide as long, with the lower lateral angles very much produced, basal teeth two in number, situated one on each side, reflected portion seven-denticulate; intermediate tooth much longer than broad, with a long process extending laterally from the base, which is also provided with a central cavity and a projection on the inner side of the base, the reflected cusp with six denticulations; the inner lateral has a long projection or shank to the base, which is greatly thickened on the outer margin, and the reflected cusp is twelve-denticulate; outer lateral very long and narrow, arcuate, apparently very finely denticulate on the summit (when magnified seven hundred diameters.) With low powers it is apparently smooth. Troschel found the formula of *B. thermalis*, a European form, to be as follows: rhachidian, $\frac{9}{1+1}$; intermediate, 6; middle lateral, 18; outer lateral smooth (o). (Vide Stimpson.)

Distribution: Europe and America.

138. **Paludestrina nickliniana** Lea, 1839. Pl. xxvi, fig. 11.

Paludina nickliniana LEA, Trans. Amer. Phil. Soc., VI, p. 92, pl. xxiii, fig. 109, 1839.

Amnicola attenuata, HALDEMAN, Monograph, pt. 4, p. 3 of wrapper, pl. i, fig. 13, 1844. (Variety.)

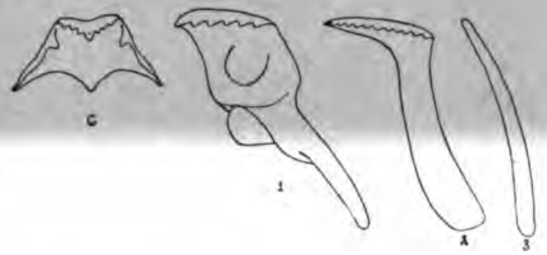

FIG. 122.

Radula of PALUDESTRINA NICKLINIANA Lea. (After Stimpson.) C, central tooth; 1, intermediate tooth; 2, 3, lateral teeth.

Shell: Elongately ovate, turreted; color greenish-horn; surface shining, lines of growth numerous, crowded, raised so as to roughen the surface of the shell; sutures deeply impressed; whorls four to four and one-half, very convex; spire elevated, rather sharply conical; apex small, round, almost concealed in the volution of the second whorl; aperture roundly ovate; peristome sharp, a little thickened on the inside, continuous, the columellar lip being covered with a raised callus which connects the terminations; base of shell rounded; umbilical region rimate and indented.

Length, 4.00; width, 2.00; aperture length, 1.25; width, 1.10 mill. (9690.)
" 4.50; " 2.00; " " 1.50; " 1.25 " (9691.)
" 4.25; " 2.00; " " 1.25; " 1.00 " (9691.)

Animal: Not thoroughly examined, but with a narrow, rounded foot, tapering, blunt-pointed tentacles and general blackish color.

Radula formula: $\frac{1}{0}+\frac{1}{12}+\frac{1}{6}+\frac{7}{1-1}+\frac{1}{6}+\frac{1}{12}+\frac{1}{0}(3-1-3)$. See generic description (Fig. 122).

Distribution: Eastern part of the United States from Michigan to Florida.

Geological distribution: Pleistocene.

Habitat: In the smaller ponds and rivers, clinging to water weeds and algæ.

Remarks: *Nickliniana* is a common little species, easily recognized by its narrow, turreted shell and well-rounded whorls. The animals are gregarious, congregating together by hundreds. Frequently a piece of water-cress will be found literally black with the shells of this species. It has been found only in the southern region.

GENUS **SOMATOGYRUS** Gill, 1863.

"*Shell:* Short, thin, simply striate, distinctly umbilicated and with 4–6 whorls; the body-whorl subglobose, more or less shouldered above; the spire small and the suture impressed. Aperture oblique (upper part most advanced) rhombo-ovate, narrowly rounded in front and behind; peritreme thin and acute, appressed behind, below the upper angle, to the whorl, and with its entire margin in the same plan. Operculum subspiral, corneous, but comparatively thick and strong and with its inner margin convex."

"*Animal:* Foot short. Snout robust and considerably longer than in *Amnicola*. Tentacles tapering, pointed. Verge (of *S. isogona* Say=*subglobosus* Say) compressed and bifid, the inner branch being much larger than the outer, but no longer than the basal part; while the outer is short, somewhat triangular and pointed, and contains the canal, which is conspicuous from its white color."

"The lingual dentition of the type is as follows: Rhachidian tooth short and very broad and trilobed below, with the outer angles much produced and narrow; cusp armed with seven denticles; basal denticles four on each side, the innermost largest but not reaching the inferior margin of the tooth, and the others gradually decreasing in size outwardly, the outermost being obtuse and rather a lobe than a denticle. Intermediate tooth with the body perforated, and the peduncle more than twice as long as the body; cusp 7-denticulated, the third denticle (counting from within) being twice as broad as the others. Inner lateral tooth with fourteen denticles at the summit. Outer lateral tooth also with fourteen denticles." (Stimpson.)*

Distribution: Central parts of North America.

139. **Somatogyrus subglobosus** Say. Text figure 123.
Paludina subglobosa SAY, Journ. Phil. Acad., Vol. V, p. 25, 1825.
Melania isogona SAY, New Harm. Diss., Vol. II, p. 227, 1829.
Paludina pallida LEA, Trans. Amer. Phil. Soc., Vol. VI, p. 22, pl. xxiii, fig. 104, 1839. (Young.)

Shell: Subglobose, solid, somewhat depressed; color yellowish-horn; surface shining; lines of growth fine, oblique, crowded; sutures much impressed; apex small, rounded, subhyaline; aperture orbicularly-ovate, somewhat produced at the lower part, whitish inside; spire short, depressed, rounded; whorls four, convex, the last swollen and all rapidly increasing; peristome simple, sharp, rather thick, the terminations joined by a light callus; base rounded, umbilicus small, narrowly open.

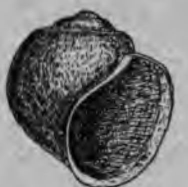

FIG. 123.
SOMATOGYRUS SUBGLOBOSUS Say. (Original.)

Length, 7.00; width, 6.50; aper. length, 5.00; width, 4.75 mill. (coll. Jensen).

Animal: Not examined.

Radula formula: $\frac{2}{12}+\frac{1}{7}+\frac{1}{3+7+3}+\frac{1}{7}+\frac{2}{12}$ (3—1—3); the central tooth almost square, the lower outer corners very much produced and the basal margin with a projection of a squarish shape; reflection seven-cuspid, the central cusp very long and sharp, reaching almost to the basal margin of central projection, side cusps shorter; the lateral projections of the base of attachment are armed with three blunt, rounded denticles, of which the highest is about three times the length of the other two; intermediate tooth similar to that of *integer*, excepting that the perforation has a little lid or door which hangs below the base of attachment; lateral teeth as usual, with about twelve denticles, those of the first tooth larger than those of the second (Fig. 124). (Stimpson.)

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* Researches upon the Hydrobiinæ, p. 21, 22. Stimpson remarks that the holes in the appendage of the intermediate tooth may be simply pits. I have not been able to either prove or disprove this statement.

Distribution: Ohio Valley; Ohio to Iowa, Michigan and Wisconsin south to Kentucky.

Geological distribution: Pleistocene.

Habitat: Found in small ponds, ditches, sloughs and rivers where there is a muddy or clay bottom.

Remarks: This is the largest species of the genus found in the area under consideration; this fact, together with its subglobose form, will distinguish it. It is three or four times the size of *S. integer*. *Subglobosus* is fairly common and has been found by Messrs. Ferriss and Jensen, the former at Joliet and the latter on the lake shore and in George Lake. The animal has not been observed. The spire of the shell varies considerably in height, some being much more elevated than shown in the figure.

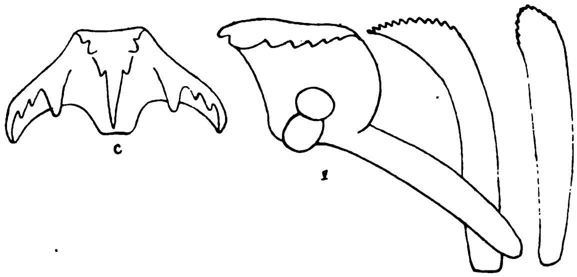

FIG. 124.

Radula of SOMATOGYRUS SUBGLOBOSUS Say. (Stimpson, Hydrobiinæ, Fig. 14.) C, central tooth; 1, intermediate teeth; 2, 3, lateral teeth.

It has been found fossil by Mr. Jensen in sand banks on the lake shore north of Graceland avenue.

140. **Somatogyrus integer** Say, pl. xxvi, fig. 2.

Melania integra SAY, New Harm. Diss., Vol. II, p. 276, 1840.

Amnicola depressa TRYON, Proc. Phil. Acad., p. 452, 1862. (Variety.)

Shell: Orbicular, solid, depressed; color subhyaline, sometimes inclining to dark horn; surface shining, lines of growth oblique, fine, numerous, crowded, somewhat raised; sutures rather deeply impressed; apex small, rounded; aperture roundly ovate, somewhat produced at the lower part, subhyaline inside; spire short, rounded; whorls four, convex, the last swollen, all rapidly enlarging in size; peristome sharp, simple, rather thick, the edge placed obliquely to the axis of the shell; columellar lip thickened by a somewhat heavy callus which covers the umbilicus, leaving only a faint indication of perforation; base of shell rounded.

Length, 3.50; width, 3.00; aperture length, 2.50; width, 1.50 mill. (10236.)
" 4.00; " 3.00; " " 2.50; " 1.75 " (10236.)

Animal: With a short, rounded foot; tentacles of medium size, rather thick at the base and tapering to a point; eyes placed on swellings at the outer, upper side of the tentacles; rostrum short, blunt, very large; verge very large, swollen, the extremity bifid, one bifurcation being longer than the other; the inner bifurcation is the shorter and contains the canal. (vide Stimpson.) (Fig. 125.)

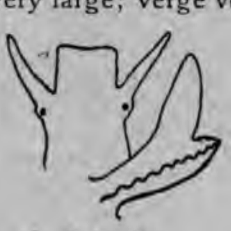

FIG. 125.
Head and verge of SOMATOGYRUS INTEGER Say. (From Stimpson Res. on Hydorb., Fig. 13.)

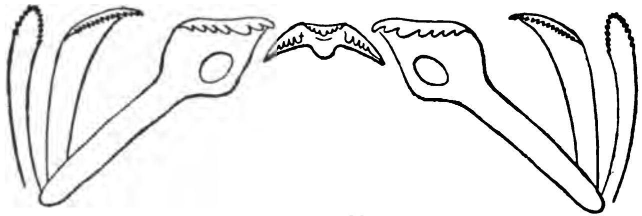

FIG. 126.
Radula of SOMATOGYRUS INTEGER Say. (Stimpson, Hydrobiinæ, Fig. 11.

Radula formula: $\frac{1}{14}+\frac{1}{14}+\frac{1}{7}+\frac{7}{4-4}+\frac{1}{7}+\frac{1}{14}+\frac{1}{14}$ (3 – 1 – 3); see generic description (Fig. 126).

Distribution: Ohio Valley; Ohio west to Iowa, Michigan south to Kentucky.

Geological distribution: Pleistocene.

Habitat: Found on muddy on clayey bottom in water from five or six inches to five or six feet in depth.

Remarks: *S. integer* is known by its globose shell and peculiar aperture. The spire is a trifle elevated. The *S. depressus* can be considered only a variety. This species is rather common and widely distributed, being found in both the southern and western regions.

Subfamily Pomatiopsinæ.

Shell: Elongated, perforated; peristome continuous. Foot with lateral sinuses. Operculum paucispiral, without internal process. Amphibious. (Tryon.)

GENUS **POMATIOPSIS** Tryon.

Shell: Elongated, turreted, smooth, subumbilicated; aperture roundly ovate; peristome reflected; operculum corneous.

Animal: With a broad foot, truncated before, rounded behind; tentacles short, pointed, subulate; rostrum large, round, blunt; verge large, broad, rather flat, coiled one and one half times on itself. Jaw as in *Amnicola*, but smaller. Radula formula 3–1–3; central tooth rather small, square, but a little broad at the base, where are two denticles, reflected cusp tridentate; laterals long and somewhat narrow, the inner lateral, however, being broader than the two outer, reflected cusp denticulate. The intermediate lateral is four-dentate, and the outer laterals five-dentate.

Distribution: Eastern North America.

KEY TO SPECIES OF POMATIOPSIS.

A. Shell elongated, acute, whorls six .... *lapidaria*

B. Shell conical, proportionately wider than A, whorls four .... *cincinnatiensis*

141. Pomatiopsis cincinnatiensis Anthony, pl. xxvi, figs. 8, 9.

Paludina cincinnatiensis ANTHONY, Bost. Journ. Nat. Hist., Vol. III, pt. 1 and 2, p. 279, pl. iii, fig. 3, 1840.

Shell: Conical, turreted; color greenish or brownish horn; surface shining, lines of growth crowded together; apex well rounded, obtuse, nuclear whorls smooth, polished; spire short conic in the male but more elongated in the female; sutures deeply impressed; whorls four, well rounded, somewhat ventricose; aperture orbicular; peristome rather thin, continuous, appressed to the body-whorl; last whorl very ventricose in the male but not so much so in the female; base of shell rounded; umbilicus narrow, deep.

Length, 4.50;	width, 2.30;	aperture length, 1.50;	width, 1.25 mill.	(12478) ♀
" 5.00;	" 3.50;	" " 2.10;	" 1.50 "	(12478.) ♂
" 4.00;	" 2.10;	" " 1.50;	" 1.25 "	(12478.) ♀

Animal: Similar to that of *P. lapidaria.*

Radula: Not examined.

Distribution: Western New York west to Iowa and Minnesota, Northern Michigan south to the Ohio River.

Geological distribution: Pleistocene.

Habitat: Similar to *P. lapidaria*, but clinging to stones when in the water.

Remarks: *Cincinnatiensis* is more common than *lapidaria*, at least in the area under consideration. This species may be distinguished from *lapidaria* by its fewer whorls and more robust shell; the spire is also longer and more attenuated in *lapidaria* than in the present species. The male shell is much wider than that of the female, the last whorl of the former being much enlarged to accommodate the extraordinarily large verge. The females have rather long and elongated shells. (Compare figures.) This species has been found only at Joliet, in the western region.

142. **Pomatiopsis lapidaria** Say, pl. xxx, fig. 33; pl. xxxi, fig. 12.
Cyclostoma lapidaria SAY, Journ. Phil. Acad., Vol. 1, p. 13, 1817.
Paludina lustrica SAY, Journ. Phil. Acad., Vol. II, p. 175, 1821.

Shell: Elongated, turreted; color dark brownish-horn; surface shining, lines of growth crowded, slightly wrinkled, numerous; apex rounded and depressed, two nuclear whorls smooth, polished, horn-colored; spire long-conic, turreted; sutures very much impressed; whorls six, well rounded; aperture roundly ovate, dark colored inside; peristome thin, continuous, reflected so as to form a rounded rim for the aperture; the last whorl, near the aperture, is almost free from the body-whorl; base of shell rounded; umbilicus round and deep.

Length, 7.00; width, 3.50; aperture length, 2.00; width, 1.75 mill. (10226.)
" 6.50; " 3.00; " " 2.00; " 1.50 "

Animal: With a short, broad foot, slightly produced at the anterior outer corners; rounded behind; foot provided with three sinuses, of which one separates the foot into an anterior and a posterior part; above this there is a sinus at right angles with the first, which separates the foot from the body, the upper fold of which merges into the operculigerous lobe posteriorly; above this there are two folds, one extending from the lower base of the rostrum to the base of the tentacle, and the other from the former point to and beyond the constricted portion called the neck; rostrum rather long, blunt, containing the mouth on the lower side; tentacles short, pointed, tapering, carried resting by the side or base of the rostrum, never elevated as in the pulmonates; eyes situated on the outer side of swellings at the base of the tentacles; verge very large, situated in the middle of the back, some distance behind the head, coiled one and one-half times, end pointed, outer margin smooth, inner margin wrinkled (Fig. 127). Operculum thin, horny, subspiral, not differing materially from *Amnicola limosa* Say.

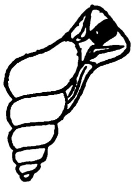

FIG. 127.
Animal of POMATIOPSIS LAPIDARIA Say. (Binney, Fig. 187.)

Radula formula: $\frac{1}{5}+\frac{1}{5}+\frac{1}{4}+\frac{3}{2+2}+\frac{1}{4}+\frac{1}{5}+\frac{1}{5}$ (3—1—3); central or rhachidian tooth as broad as high, tridentate, denticles on base of attachment two on each side, directed inward; intermediate tooth longer than wide, four-denticulate; lateral teeth narrower than intermediate, five-denticulate the denticulations subequal (Fig. 128).

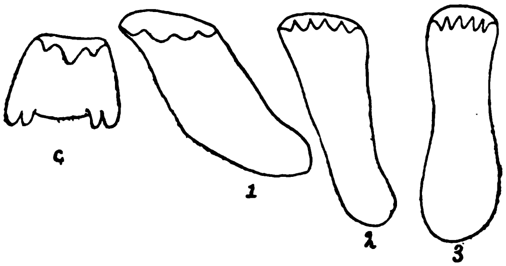

FIG. 128.
Radula of POMATIOPSIS LAPIDARIA Say. (From Nature, after Stimpson.) C, central tooth; 1, intermediate tooth; 2, 3, lateral teeth.

Distribution: New York to Iowa, Michigan to Missouri and Georgia.

Geological distribution: Pleistocene; Loess.

Habitat: Living in fresh water or on land (amphibious), frequenting, when in water, the vicinity of fresh-water plants;

when on land preferring moist localities. Though essentially terrestrial, the gills are of the usual pectinated form.

Remarks: Pomatiopsis is immediately distinguished from the allied group *Amnicola* by the peculiar "stepping" mode of progression. This is accomplished as follows: The anterior part of the foot is placed firmly on the ground, then the posterior part is pulled forward; next the rostrum is firmly attached to the ground and the posterior part is also attached, allowing the anterior part of the foot to be placed forward. In this manner the mollusk "steps" along at a lively gait. The author has seen this species traveling in the water with the rostrum bent downward, moving about like a hound on the scent.*

A species of worm (*Histrionella pomatiopsidis* Stimpson) infests the branchial cavity of *Pomatiopsis.*

The species is confined to the southern and western regions, and seems to be quite rare. It is sometimes found associated with *P. cincinnatiensis.* See remarks under that species.

FAMILY VALVATIDÆ.

"Lingual membrane with teeth in seven series (3—1—3); the central tooth broad, with hooked and denticulated apex, the laterals lanceolate-hooked and denticulated. Rostrum produced; tentacles cylindrical, eyes sessile at their exterior bases. Mantle simple in front; gill plumose, exposed, the lamina primate, spirally twisted, protected by a long, slender respiratory lobe. Foot bilobed in front. Operculum horny, orbicular, spiral, many whorled; whorls with a thin, elevated edge (Fig. 129). Shell spiral, turbinate or discoidal, covered with an epidermis; aperture with the peritreme entire." (Binney.)†

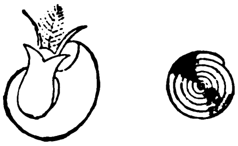

FIG. 129.

Animal and operculum of VALVATA TRICARINATA Say. (Binney, L. and Fr. Wat. Sh., pt. III, Figs. 10, 11.

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*For a full account of the "stepping" or "looping" of *Pomatiopsis,* see Stimpson's "Researches upon the Hydrobiinæ and Allied Forms," Smithsonian Miscellaneous Collections, No. 201, pp. 29-36.

†Land and Fresh Water Shells, N. A., Part III, p. 8.

The genitalia is very interesting; the ovotestis is very long and is buried in the folds of the liver; the ovisperm duct is very long and narrow and enters the uterus near the upper part; the albuminiparous gland is long-oval in shape and has a long, narrow duct which empties into the uterus near the ovisperm duct; the receptaculum seminis is long and rather thick, and the upper part is attached to the albuminiparous gland; the uterus is very large and very wide, narrowing toward the opening (atrium); the vas deferens is very short, narrow, and enters the uterus near the lower third; the penis is very large, long, thick and fleshy, and appears like a third tentacle on the right side of the animal, behind the right tentacle (Fig. 130).

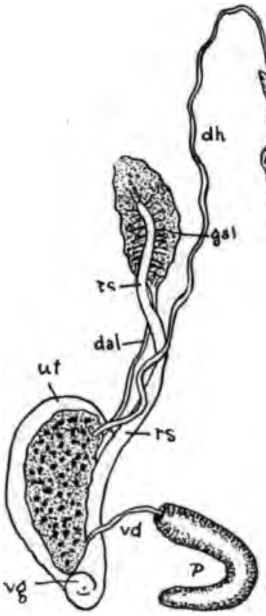

Fig. 130.

Genitalia of VALVATA CRISTATA. (Bronn, Klassen und Ordnungen der Weichthiere, Malacozoa, pl. xxxviii, Fig. 23.) dal, duct from albuminiparous gland; dh, ovisperm duct; gal, albuminiparous gland; gh, ovotestis; p, penis; rs, receptaculum seminis; ut, uterus; vd, vas deferens.

GENUS **VALVATA** O. F. Müller.

Shell, Animal and *Dentition:* As in the family.

Distribution: World-wide.

KEY TO SPECIES OF VALVATA.

a. Shell with rounded whorls..*sincera*

b. Shell bi- or tricarinate ....
  1. Spire depressed...*bicarinata*
  2. Spire elevated ....*tricarinata*

143. Valvata sincera Say, pl. xxx, fig. 31; pl. xxxii, fig. 15.
Valvata sincera SAY, Long's Expedition, p. 264, pl. xv, fig. 11, 1824.
Valvata depressa, KÜSTER (pars) in CHEMN., ed. 2, p. 88, 1852.
Valvata striata LEWIS, Proc. Phil. Acad., p. 260, 1856.
Valvata lewisii CURRIER (descr.?)

Shell: Depressed, more or less discoidal, rather solid; color brownish, transparent to opaque; surface shining, lines of growth numerous, regular, crowded, sometimes encircled by a few spiral lines; apex large, round, almost concealed in the succeeding whorls; spire very flat, almost discoidal; whorls three and one-half, rounded, rapidly increasing, the last considerably deflected; sutures impressed; aperture round, continuous, whitish or brownish inside; peristome rather thick, simple, continuous, the columellar portion being simply appressed against the body-whorl; base rounded, umbilicus round, deep, exhibiting all the volutions.

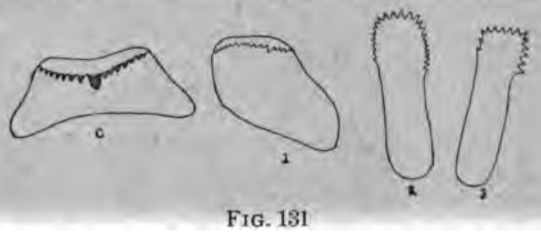

FIG. 131

Radula of VALVATA SINCERA Say. (Original.) C, central tooth; 1, intermediate tooth; 2, 3, lateral teeth.

Length, 2.50;	width, 4.50;	aperture length, 1.60;	width, 1.75 mill.		(10496.)
" 2.25;	" 6.00;	" " 2.10;	" 2.10	"	(12141.)
" 2.25;	" 5.00;	" " 2.00;	" 2.00	"	(12141.)

Animal: With short, wide foot, bifurcated before and rounded behind; head large; rostrum of good size, with a black line extending down the center of the upper surface; color yellowish-white, transparent; branchia plumose, translucent; eyes black, situated at the base of the tentacles; tentacles long and tapering, terminating obtusely. The branchial filament is yellowish-white in color, and is protected by a respiratory lobe; the branchial cavity is brownish or blackish.

Radula formula: $\frac{2}{+}+\frac{1}{+}+\frac{1}{7-1-7}+\frac{1}{+}+\frac{2}{+}$ (3—1—3); (Mus. No. 12772); central tooth wider than high, concave on the base and with somewhat attenuated ends; reflection fifteen-cuspid, the center cusp the largest; intermediate tooth squarish, much produced at the outer, lower angle, and with the cusp finely denticulated; lateral teeth long and narrow, finely denticulated at the apex and partly down the sides (Fig. 131).

Distribution: New England to Great Slave Lake, south to Georgia and Louisiana. Dredged in Lake Superior at four to thirteen fathoms. Alaska. (Randolph.) Manitoba. (Hanham.)

Geological distribution: Pleistocene; Loess.

Habitat: Found plentifully in lakes, ponds and rivers, where there is little or no current.

Remarks: This is a very common species, easily distinguished by its discoidal form and rounded whorls. Like the *Limnæids* it delights to float on the surface of the water, shell downwards. It is very active and not at all timid in activity. It seems to be confined to the southern and northern regions. Hundreds of this species, as well as others, are thrown up on the shore in North Chicago after a storm from the north.

144. **Valvata tricarinata** Say, pl. xxxii, fig. 14.

Cyclostsma tricarinata SAY, Jour. Phil. Acad., Vol. I, p. 13, 1817.

Valvata carinata SOWERBY, Gen. Sh., pl. xli, fig. 2.

Valvata unicarinata DE KAY, N. Y. Moll., p. 118, pl. vi, fig. 129, 1844. (Variety.)

Valvata tricarinata var. *simplex* GOULD, Invert, Mass., p. 226, fig. 126, 1844. (Variety.)

Tropidina carinata CHENU, Man. de Conch., Vol. II, p. 312, fig. 2232.

Valvata tricarinata var. *confusa* WALKER, The Nautilus, Vol. XV, p. 124, fig. 2, 1902. (Variety.)

Shell: More or less turbinate, thin; color varying from dirty white to horn-colored, translucent; surface shining, lines of growth faintly marked, crowded; apex large, rounded, whitish (or sometimes reddish), almost concealed in some specimens by the volutions of the post-nuclear whorls; spire generally elevated; whorls three and one-half, strongly carinated, rapidly increasing; the carinæ are normally three in number, one on the periphery, one on the shoulder of the whorls and one on the base of the shell, but one or all of these may be wanting; sutures very pronounced; aperture rounded, in some specimens angled by the carinæ, made continuous by a somewhat elevated columellar callus; columella straight, simple; base rounded or keeled; umbilicus round and deep, funnel-shaped when the base is carinated.

Length, 4.00; width, 4.00; aperture length, 2.00; width, 2.00 mill.

Animal: Similar to *bicarinata.*

Radula: Similar to that of *sincera.* The writer could discover no differences of importance.

Distribution: New England to Iowa, Michigan and Manitoba.

Geological distribution: Pleistocene; Loess.

Habitat: Same as *sincera.*

Remarks: This very distinct species is easily known by its elevated, tricarinate whorls. It is very variable, and occurs from barely unicarinate to very strongly tricarinate. The variation, however, does not seem to be confined to any particular locality and for this reason the names given to the different degrees of carination cannot stand, except as varieties.

This species lays from ten to thirty eggs of a green color, and about fifteen days are required for the development of the egg. When hatched, the young are very active and float shell downwards on the surface of the water. Egg laying extends from March to July. *Tricarinata* is widely distributed in the area but is most common in Lake Michigan.

145. **Valvata bicarinata** Lea. Unfigured.

Valvata bicarinata Lea, Proc. Amer. Phil. Soc., Vol. II, pp. 81, 83, 1841
Walker, The Nautilus, Vol. XV, p. 122, fig. 6, 1902.

Shell: Depressed, solid, orbicular; horn-colored above and whitish beneath; surface shining, lines of growth distinct; apex large, horn-colored; spire much depressed, flattened; whorls three and one-half to four, rapidly increasing; the carinæ are normally two in number, but a third is frequently developed; one carina encircles the shoulders of the whorls and one the middle of the base, the periphery being sharply rounded; sutures pronounced; aperture rounded, angled more or less by the carinæ, continuous as in *tricarinata;* base keeled; umbilicus widely opened.

Length,	3.50;	width,	5.00;	aperture length,	2.00;	width,	2.00	mill.	(12365.)
"	3.00;	"	4.00;	" "	2.00;	"	2.00	"	(12365.)
"	3.50;	"	5.00;	" "	2.00;	"	2.00	"	(12366.)

Animal: The animal of *bicarinata* differ considerably from that of *tricarinata.* Dr. Lea described the animal as follows: "Body rather short and white, head large, tapering, slightly enlarged at the anterior termination, with a black mark passing from the neck between the eyes, tapering off and reaching nearly to the end of the snout, where there are two oblique black marks bordered in front by white, and accompanied behind by several irregular white spots, the anterior ones being the larger. Branchia translucent, superior portion blackish, bordered with white spots and occasionally obtruded; eyes round and deep black, placed at the posterior base of the tentacula, surrounded by a white area; tentacula long, rather tapering, obtuse at the end; filament rather short, translucent with longitudinal white lines; foot wide and furcate anteriorly, where minute white spots may be observed. Operculum thin, semitransparent, light horn color, increment circular and rather coarse."

"The head of the *tricarinata* is more cylindrical and enlarged at the termination, where it somewhat resembles the snout of the hog, while that of the *bicarinata* is more conical and without so sudden an enlargement at the end. The color of the *bicarinata* is lighter. In the black markings they also differ. In the *tricarinata* there is a single blotch anterior to the area between the eyes. In the *bicarinata* this extends also behind this area; and in addition may be observed two quite black marks above the mouth, which the *tricarinata* does not seem to have. The tentacula of the *bicarinata* are larger and more filiform. When in motion, the anterior portions of the lobes of the foot are pointed, and recurved or hooked."

Radula: Apparently not differing from *tricarinata.*

Distribution: Apparently the same as *tricarinata.*

Geological distribution: Pleistocene; Loess.

Habitat: Same as *tricarinata.*

Remarks: In a recent letter Mr. Bryant Walker announced that in his opinion *bicarinata* should be considered a distinct species from *tricarinata,* since the shells of the two forms are always distinguishable. Upon receipt of Mr. Walker's letter, the writer examined all of the material in the Academy's collection, besides carefully reading the descriptions of Say and Lea. The two species are undoubtedly distinct, *tricarinata* being elevated, the width equaling the height, while *bicarinata* is depressed and the height is four-fifths of the width. The former is normally *tricarinate* while the latter is *bicarinate,* although both bi- and tri-carinate forms occur in both species. In *tricarinata* the upper surface slopes *upwards* from the carina to the suture, while in *bicarinata* it slopes *downwards,* giving the upper surface a concave appearance.

Bicarinata is found in the Desplaines River and in Lake

Michigan. Beautiful and typical specimens may be collected at Joliet.

145a. Valvata bicarinata normalis Walker. Unfigured.

Valvata bicarinata normalis WALKER, The Nautilus, Vol. XV, p. 125, fig. 5, 1902.

The shell in the variety differs from *bicarinata* in being tricarinate, the middle carina very strong and placed on the periphery. The variety occurs at Joliet, Ill., and at Miller's, Ind.

The curious larva case of *Phryganea*, named by Mr. Lea *Valvata arenifera*, is found in considerable numbers in various parts of the region. The case is of exactly the same shape as that of a *Valvata*, and might be mistaken by an amateur for *V. sincera*. For a very interesting account of this larva case, see Thos. Bland, Ann. Lyc. N. H., Vol. VIII, p. 144.

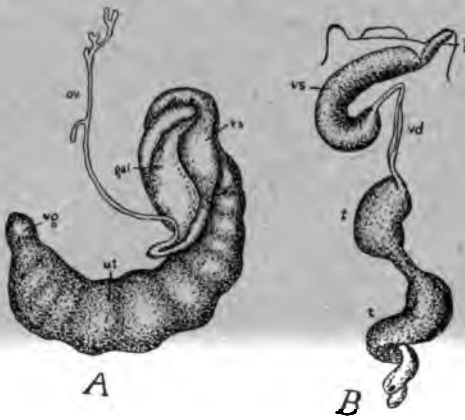

FIG. 132.

Genitalia of PALUDINA VIVIPARA Linné. (Bronn, Klass. und Ord. der Weich., taf. LXXXVIII, Figs. 5 (♀), 6 (♂). A, female; B, male; gal, albuminiparous gland; ov, ovaries; p, penis; rs, receptaculum seminis; t, testicles; ut, uterus; vd, vas deferens; vg, vagina; vs, seminal or genital bladder.

FAMILY VIVIPARIDÆ.

Shell: Globular or conical, either banded or plain and with a greenish epidermis; aperture round; peristome continuous, entire; operculum horny, annular, frequently with a spiral nucleus.

Animal: With a large, simple foot, and short, simple rostrum; tentacles short, the right one, in the male, modified to form a verge, and very large; eyes situated on peduncles at the outer bases of the tentacles. Radula with the formula 3–1–3; central tooth broad, with rounded edges on base, reflected cusp denticulated; lateral teeth longer than wide, the two inner denticulated on their reflected portions; and the outer tooth simple or denticulated.

The genitalia may be thus briefly described: In the male the penis is lodged in the right tentacle and is large and cylindrical; the seminal or genital bladder follows, being a very large, cylindrical sac, from the end of which extends the vas deferens, which terminates in two testicular lobes, one anterior and one posterior. In the female the ovaries are small and digitiform, and lead by a long, narrow oviduct into the uterus; at this point the receptaculum seminis and albuminiparous gland are placed, both being quite large; the uterus is much swollen and gut-like, and opens by a contracted portion, the vagina. The testes and ovaries are embedded in the liver (Fig. 132).

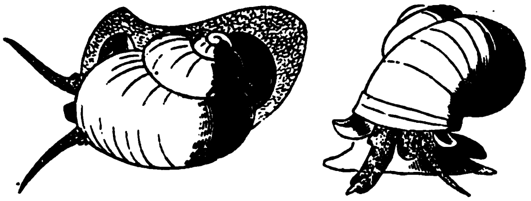

FIG. 133.
Animal of VIVIPARA. V. INTERTEXTA Say, Binney, Figs. 30, 31.) Female and male.

GENUS VIVIPARA Lamarck.

Shell: With rounded whorls frequently banded; aperture ovately rounded; peristome continuous. Operculum annular, horny.

"*Animal:* With a long muzzle and very short eye-peduncles; neck with a small lappet on the left side and a larger on the right, folded to form a respiratory siphon; gill comblike, single; tongue short; teeth single, oval, slightly hooked and denticulated; uncini 3, oblong, denticulated. The *Viviparidæ* are viviparous, the young continuing for some time after they are hatched within the parent shell." (Tryon).* (Fig. 133.)

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*S. and S. Conch., Vol. II, p. 274.

The number of denticles on the cusps varies in different species as follows: central, 7–18; intermediate, 7–12; inner lateral, 5–10; outer lateral, 5–16.

146. **Vivipara contectoides** W. G. Binney, pl. xxxvi, figs. 1, 2, 3.
Limnæa vivipara SAY, Nich. Encycl., Amer. ed., pl. ii, fig. 5, 1817. (Paludina of later editions.)
Vivipara contectoides W. G. BINNEY, L. and Fr. W. Sh., Part III, p. 23, figs. 41–44, 1865.

Shell: Rather thin, rounded, swollen; color greenish-horn, either plain or with four revolving brown bands, of which three are on the body of the whorl and one on the base, the upper whorls showing but two bands; surface shining, smooth, lines of growth numerous, fine, crowded, a trifle oblique; surface broken in one or more places by the mark of the former peristome, which leaves a black line; spire rather short, subconic; apex small, knob-shaped, elevated; sutures very deeply impressed; whorls five, regularly increasing in size, swollen; aperture nearly circular, oblique, entire, the inner wall of the aperture being placed against the body-whorl, bluish-white inside, showing the four bands through the shell; peristome entire, thin, sharp, bordered with black, reflected near the umbilicus; base of shell rounded; umbilicus narrow, deep, in some examples almost covered by the reflection of the peristome.

Length, 28.00;	width, 21.00;	aperture length, 14.50;	width, 11.50 mill.	(8840.)
" 30.00;	" 24.00;	" " 16.00;	" 13.00 "	(8845.)
" 31.00;	" 26.00;	" " 15.00;	" 12.50 "	(8841.)
" 33.00;	" 25.00;	" " 16.00;	" 13.00 "	(9130.)

Animal: With a short and very wide foot, expanded laterally before and rounded behind; tentacles short and triangular, the eyes situated on prominences on their outer sides; color dark brown with lighter patches here and there; rostrum short and thick, cylindrical, blunt; there is a short siphon on the right side and a small lappet on the left side; operculum concentric, horny, rather thin, concave, the nucleus a little below the center of left side (Pl. xxxvi, Fig. 2); operculigerous lobe on right side of body, near the center of the hinder end of the dorsal surface of the foot. Length of foot, 22.00; width, 14.00 mill. In the male *contectoides* the right tentacle is produced into a thick, cylindrical, copulatory organ, or verge, with a small hook at the end.

Radula formula: $\frac{1}{7}+\frac{1}{9}+\frac{1}{9}+\frac{1}{9}+\frac{1}{9}+\frac{1}{9}+\frac{1}{7}$ (3 – 1 – 3); central tooth with a quadrangular base of attachment, rounded above and below, reflected portion small, nine-dentate, the central cusp the largest; intermediate tooth longer than wide, somewhat sole-shaped, nine-dentate, cusp wider than high; lateral teeth longer than wide, the second nine-dentate and the third seven-dentate. The writer counted 55 rows of perfect teeth in one membrane (Fig. 134).

Distribution: Eastern United States from Michigan to New York and Florida, and from South Carolina to Arkansas.

Geological distribution: Pleistocene; Loess.

Habitat: Found in lakes and rivers, where there is a muddy bottom, more frequently where there is a quantity of grass, in water from a foot to two or three feet in depth.

Remarks: This is a very common and beautiful species. It is unlike any other mollusk found in this region, the four spiral bands easily distinguishing it. In some localities it is the predominating form, and thousands of dead shells may be found upon the shores of such localities as Wolf and Calumet lakes. It is most interesting in an aquarium, and readily moves about, its long tentacles and rounded rostrum extended to their full length, the latter bent downward, the former feeling about nervously and the shell swinging from side to side. The young have a foot almost black in color, with large, irregular white spots on the under side; they are very active. The shell is very variable in regard to the presence of the bands, some specimens being perfectly plain and others but faintly banded. It seems to be pretty widely distributed, but is most common in the southern region, in the chain of lakes.

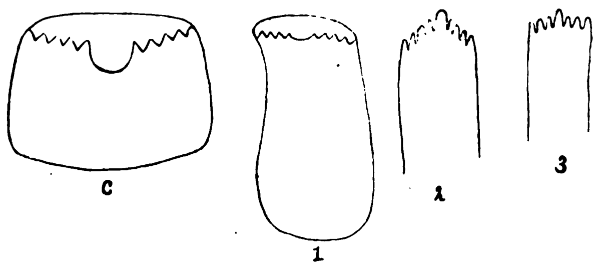

FIG. 134.

Radula of VIVIPARA CONTECTOIDES, W. G. Binney. (Original.) C, central tooth; 1, intermediate tooth; 2, 3, lateral teeth.

GENUS **CAMPELOMA** Rafinesque, 1819.

Paludina, *Vivipara* and *Melantho* of authors.

"*Shell:* Thick, solid, ovate, imperforate, spire produced; whorls rounded, smooth, covered with an olivaceous epidermis; peristome simple, continuous." (W. G. Binney.)[*]

Animal: With a large, broad, rather thin foot, "much produced beyond the snout and slightly auricled in front. Color rather light, in reddish (orange) spots on a palish white ground. Head of moderate size, snout small. Lingual teeth smooth or only minutely crenulated at their apices. Cervical lappets of moderate size, but not forming regular tubular aquiferous ducts; the right one plicated. Branchial laminæ elongate-triangular, equal in size and arranged in a single straight row both at base and tips." (Stimpson.)[†]

"The operculum is elongately-ovate, somewhat produced anteriorly and curved; thin, corneous, subconcentric, with simple nucleus near parietal wall; reddish or light brown." (Call.)

Disribution: The United States east of the Rocky Mountains.

KEY TO SPECIES OF CAMPELOMA.

A. Shell reddish or pinkish under the epidermis, especially the apex .... *rufum*

B. Shell dark olivaceous or greenish, chalky-white beneath the epidermis.

  a. Spire very short, stumpy; aperture longer than spire, produced into a sort of channel at the upper (posterior) part; shell very ponderous .... *ponderosum*

  b. Spire rather long, aperture and spire of equal length, aperture not produced.

    1. Whorls rounded; shell generally ovate, rather thin, spire somewhat depressed, aperture rounded ...... *decisum*

    2. Whorls rather flattened; shell generally elongated, solid; spire produced, aperture sigmoid......... *subsolidum*

147. Campeloma ponderosum Say, pl. xxxv, fig. 9.

Paludina ponderosa SAY, Journ. Phil. Acad., Vol. II, p. 173, 1821.
Paludina regularis LEA, Trans. Amer. Phil. Soc., Vol. IX, p. 13, 1844.
Melantho nolani TRYON, Con. Haldeman, Mon., p. 25, pl. xii, figs. 10-11, 1870.

Shell: Very heavy and solid, globosely ovate; color generally greenish, but blackish in old specimens and showing old peristome scars; surface shining, polished, smooth, lines of growth numerous, fine, crowded, crossed by delicate spiral lines; beneath the green or black epidermis the shell is pure white; apex always eroded in old specimens but in young ones showing a small, round, sunken nucleus, which is light horn color; spire generally depressed, short, conic; sutures well impressed; whorls six, rounded, bulbous or inflated, the last whorl very large, equaling over half the length of the entire shell; aperture elongately-ovate, rounded below and contracted above, where it is produced into a sort of canal; aperture bluish-white within; peristome sharp, thick, simple, margined with black; columellar lip covered by a thin coating of callus, which is bordered with black and which makes the peristome entire, joining the terminations; base of shell rounded, imperforate.

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[*] L. and Fr. W. Sh., pt. 3, p. 30.

[†] See Bull. Washburn Coll. Lab. N. H., Vol. I, No. 5, p. 153.

Length, 21.50; width 15.00; aperture length, 13.50; width, 8.00 mill. (8848.)
" 18.00; " 13.50; " " 13.00; " 8.00 " (8848.)

Animal: Not examined. Operculum longer than wide, much narrowed above, convex, horny, thin on the edges, subconcentric; the nucleus near the left margin; reddish brown in color. Length 12.50, width 7.00 mill. (Shell 21.50 mill. long.)

Radula: Not examined.

Distribution: New York west to Illinois, south to Alabama and Texas.

Geological distribution: Pleistocene; Loess.

Habitat: In the larger rivers on a muddy bottom.

Remarks: Distinguished by its heavy, solid shell and peculiar channeled aperture. The species is not generally known to inhabit this region, being usually found farther south, but the specimens before the writer are certainly *ponderosum* and they were said to have been collected in the Calumet River some years ago by Dr. J. W. Velie. The specimens were sent to Prof. R. Ellsworth Call, the well-known student of this intricate genus, who wrote as follows concerning them: "The specimens are certainly *Campeloma ponderosum*, mostly juniors, and one about two-thirds grown. They are typical of that form. I seriously question that your collector found them in the place indicated. It will be very interesting indeed to have this settled by additional specimens, which will be the only proof beyond doubt." The region has been very carefully searched for additional specimens but up to the present time none have been found. It has been admitted to this list only for the reason that others may identify it, if collected in this region by any student.

148. **Campeloma rufum** Haldeman, pl. xxxvi, figs. 4, 6.

Paludina rufa HALDEMAN, Mon., p. 3 of wrapper, pt. 3, pl. iii, fig. 1, 1844.

Melantho gibba CURRIER, Amer. Journ. Conch., Vol. III, p. 112, pl. vi, fig. 3, 1867.

Shell: Thick, but not heavy, elongately ovate or globose; color olive green to light horn, especially near the sutures, showing old peristome marks as in *ponderosum;* beneath the epidermis the shell is pinkish or reddish and the apex is pinkish; surface shining, polished, smooth, lines of growth numerous, raised into conspicuous ridges here and there, crossed by more or less distinct spiral striæ; sometimes malleated on body-whorl; apex small, rounded, pinkish, eroded in some specimens; spire obtusely conic, somewhat elevated; sutures well impressed; whorls five and one-half to six and one-half, convex on the sutures but rather flat-sided on the peripheral portion of the whorl; last whorl (at the aperture) from two-fifths to one-half the length of the entire shell; aperture obliquely ovate, narrowed above, pinkish within, bluish-white on the columella and near the peristome; peristome acute, simple, sigmoid, terminations joined by a bluish-white callus, which is reflected over the parietal wall and covers the umbilicus; base of shell rounded. Operculum as in *decisum.*

Length,	29.00;	width,	17.00;	aper.	length,	14.00;	width,	9.00	mill.	(8859.)♂
"	23.50;	"	14.50;	"	"	13.00;	"	8.00	"	(10111.)♂
"	20.00;	"	13.00;	"	"	11.50;	"	8.00	"	(10111.)♂
"	20.50;	"	13.00;	"	"	11.50;	"	7.75	"	(10115.)♂
"	27.00;	"	19.00;	"	"	14.50;	"	11.00	"	(12866.)♀

Animal: Not differing materially from *decisum.*

Radula: As in *decisum.*

Distribution: Connecticut and Massachusetts west to Iowa, south to Tennessee and Alabama.

Geological distribution: Pleistocene; Loess.

Habitat: Found rather plentifully on muddy bottoms in rivers and lakes.

Remarks: This distinct and beautiful species is generally confounded with *decisum*, but may always be distinguished by the peculiar pinkish tinge of the substance of the shell beneath the epidermis, and the pinkish apex. In form the shell much resembles both *decisum* and *obesum*, as well as some forms of *subsolidum*. The females are very globose and may easily be distinguished from the males, which are comparatively slender. The interior of the aperture is frequently bluish or purplish, and the pinkish substance of the shell cannot be made out until the shell is examined by transmitted light. An excellent method of identifying this species is to scratch the epidermis from a spot on the shell, when the beautiful pink tint will be seen. This seems to be a rather widely distributed species and is found in all parts of the territory. Mr. T. Jensen has a very fine, large, reversed specimen in his collection.

149. **Campeloma decisum** Say, pl. xxxvi, figs. 5, 7.
Limnæa decisa SAY, Nich. Encycl., ed. 1, 1817.
Paludina incrassata LEA, Proc. Amer. Phil. Soc., Vol. II, p. 243, 1842.
Paludina decapitata ANTHONY, Proc. Phil. Acad., p. 71, 1860.
Melantho melanostoma CURRIER (MSS.?)
Melantho geniculum CONRAD, N. Fr. W. Sh., U. S., p. 48, pl. viii, fig. 3, 1834. (Variety.)

Shell: Elongate-ovate, rather solid, subfusiform; color dark green, generally very uniform, but with here and there a brown streak representing a former edge of the aperture; surface smooth, shining, lines of growth numerous, very fine, crowded, crossed by numerous microscopic revolving lines; beneath the green epidermis the shell is chalky white, apex (when present) very small, rounded, color light horn; spire elevated, conic, obtuse near the apex, frequently truncated; sutures well impressed; whorls six, rounded, the upper whorls of the spire being frequently eroded; aperture elongately-ovate, very nearly entire, rounded below and a little contracted above, bluish-white within; peristome acute, simple, a dark brown band bordering it on the outside; the columellar wall of the aperture is covered by a callus which is bordered with dark brown and connects the terminations of the peristome; the parietal wall and columella form almost a straight line in typical (male) specimens; base rounded, made imperforate by the reflection of the aperture.

Lgth., 28.50;	width, 17.50;	aper. lgth., 15.50;	width, 10.00	mill.	(10110.)	
" 26.00;	" 12.50;	" " 14.50;	" 9.00	"	(8858.)	Rev d
" 23.00;	" 16.00;	" " 13.00;	" 9.00	"	(8853.)	
" 21.00;	" 15.50;	" " 12.00;	" 8.50	"	(8856.)	

Animal: Pale or bluish white, covered over thickly with salmon-colored spots, under portion of foot pale bluish-white; head small, distinct; rostrum small, cylindrical; tentacles rather long and tapering, the eyes situated on the outside on an enlargement of the tentacles one-third the distance between the base and tip; in the male the right tentacle is modified to form the verge; foot very large, broad, produced in front, and much in advance of the head and tentacles. Length of foot, 39.00; width, 19.00 mill. Foot truncated in front and slightly auriculated, rounded behind, translucent (Fig. 135). Operculum longer than wide, convex, subconcentric, with the nucleus near the left margin; dark reddish brown in color. Length, 11.00; width, 6.00 mill.

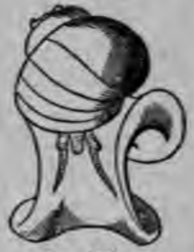

FIG. 135.
Animal of CAMPELOMA DECISUM Say. Female. (Binney, Fig. 68.)

Radula formula: 3–1–3, central tooth very broad, the lower corners of the base of attachment attenuated; reflection simply hooked, without denticulations; intermediate tooth similar to central, but narrower; second and third lateral teeth very long and narrow, somewhat fang-shaped, simple (Fig. 136).

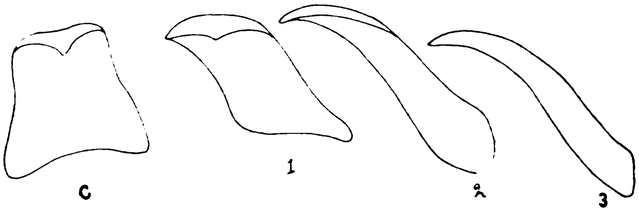

FIG. 136.
Radula of CAMPELOMA DECISUM Say. (Original.) C, central tooth; 1, intermediate tooth; 2, 3, lateral teeth.

Distribution: Massachusetts to Illinois and Minnesota, south to Tennessee and Virginia. In British America from Nova Scotia to Saskatchewan River.

Geological distribution: Pleistocene; Loess.

Habitat: Found generally on a muddy bottom almost buried from sight. Sometimes, when found in a quiet nook, they may be seen crawling over the surface of the mud. They seem to prefer large bodies of water.

Remarks: This species is rare in this region, and the specimens found are not typical. Professor Call remarked that of a lot of *Campeloma* sent him only 5 per cent were *decisum*, the others being *subsolidum*. Many specimens are similar to *rufum*, but the pink shell will always distinguish that species. It is always confounded with *subsolidum*, and many of its varieties are difficult to distinguish from that species. *Decisum* has well-rounded whorls, a somewhat depressed spire, broadly conical, and the epidermis is of a beautiful green. *Subsolidum* has always a more solid shell, with a longer spire, more flat-sided whorls and (in this region) a greenish horn-colored shell.

In a lot of specimens from Wolf Lake, the females (July 16, 1896) were filled with ova in an advanced stage of development. One specimen had twenty ova measuring 5 mill. in diameter, and the yolk was of a beautiful transparent horn color.

The oviduct of this species is infested by a parasite, *Heterostromum echinatum* Diesing, which is found in considerable numbers, and the intestine is tenanted by another parasite, *Anoplophrya vermicularis*.

On February 23, 1897, a specimen of this species gave birth to six young which were very active. A few days later she added twelve more to that number, making eighteen in all. The young all died three weeks after birth. When born the animal is very transparent and vitreous, with a very large foot. The shell is 3 mill. in length, and consists of about two whorls. The operculum is very thin and transparent, almost structureless, and measures 1½ by 1 mill. The shell might easily be mistaken for *Amnicola limosa*. No reversed specimens occurred in this brood. (Mus. No. 12353.)

Decisum is found, rather sparingly, however, in all parts of the territory. On the old lake beaches it may be found in a fossil condition.

150. **Campeloma subsolidum** Anthony, pl. xxxvi, figs. 8-12.
Paludina subsolida ANTHONY, Proc. Phil. Acad., p. 71, 1860.
Paludina exilis ANTHONY, l. c., p. 71, 1860.
Paludina milesii LEA, l. c., p. 156, 1863.

Shell: Elongate, very solid, more or less malleated; color horn or light green, showing former peristome marks as in *decisum;* surface polished, smooth save for the somewhat elevated, crowded growth-lines which roughen the shell to some extent; the shell beneath the epidermis is chalky white; apex small, similar to *decisum*, but more prominent; spire elevated, elongated, conic; sutures impressed, almost channeled; whorls six to seven in fully adult specimens, rather flat-sided, sloping near the sutures, where they are almost angular; the whorl occupies three-fourths of the entire length of the shell, and the periphery is perceptibly flattened; aperture broadly ovate, rounded below and contracted above; forming a sort of "bay" at the columella, white or bluish-white within; peristome thin, acute, simple, the terminations connected by a rather heavy columellar callus which is reflected over the umbilicus; the parietal callus is bluish-white and is sometimes bordered by a black stripe; base rounded, imperforate, somewhat wrinkled. Operculum similar to that of decisum.

Length, 32.00;	width, 20.00;	aper. length, 17.00;	width, 11.00	mill.	(10113.)
" 31.00;	" 19.00;	" " 16.50;	" 11.00	"	(10113.)
" 29.00;	" 17.50;	" " 15.00;	" 10.00	"	(8857.)
" 30.00;	" 18.00;	" " 15.50;	" 10.00	"	(8844.)
" 40.00;	" 23.00;	" " 21.00;	" 13.50	"	(9343.)

Animal: Similar to *decisum.*

Radula: Same as that of *decisum.*

Distribution: Massachusetts to Illinois and Michigan, south to Central Ohio.

Geological distribution: Pleistocene; Loess.

Habitat: Similar to *decisum.*

Remarks: This species is almost always confounded with *decisum.* It is a more heavy shell, the spire is more produced, the aperture is more sigmoid and the whorls are more flat-sided. The two species are almost always found associated together and it is a question whether they do not interbreed. It is certainly very difficult to separate some of the forms of these two species. This is the most common *Campeloma* in this region and grows to a large size. In Wolf Lake it is very plentiful, and in the North Branch of the Chicago River it is quite common and very typical. It is universally distributed and has been found fossil on the old lake beaches and by Mr. Jensen in sand banks on the lake shore north of Graceland avenue.

XI. CHICAGO BIBLIOGRAPHY.

The writer has been able to find but three papers (besides his own) relating to the Mollusca of the area under consideration. All available works have been carefully examined. The Chicago drainage area seems to have been but little studied.

1. Catalogue of Animals Observed in Cook County, Ill.

Prepared for the Illinois State Agricultural Society by Robert Kennicott, The Grove, West Northfield, Ill. (Transactions of the Illinois State Agricultural Society, Vol. I, 1853-1854, p. 595.)

MOLLUSCA.

Unio alatus Say.
Unio costatus Raf.
Unio iris Raf.
Unio bullatus Raf.
Unio fragilis Raf.
Unio luteolus Lam.
Unio dilatatus Raf.
Unio coccineus Hild.
Unio cardium Raf.
Unio parvus Barnes.
Alasmodonta calceolata Late.
Cyclas similis Say.
Helix monodon Rackett.
Helix profunda.
Planorbis campanulatus Say.
Planorbis trivolvis Say.
Limnæa reflexa Say.
Limnæa fragilis Linne.
Limnæa emarginata Say.
Physa heterostropha Say.
Paludina decisa Say.
Melania carinata.
Melania semicarinata Say.

Of the above, U. *costatus=undulatus* Barnes; U. *iris=iris* Lea (?); U. *bullatus=pustulosus* Lea; U. *fragilis=gracilis* Barnes; U. *dilatatus=gibbosus* Barnes; U. *cardium=ventricosus* Barnes; A. *calceolata=calceola* Lea; L. *fragilis=stagnalis* Linné; L. *emarginata=catascopium* Say; M. *carinata=semicarinata* Say, the latter a species not found in the present territory. The list shows how little was known at that time concerning the varied molluscan fauna of this region.

2. Notes on Fresh-water Mollusca Found in the Vicinity of Chicago, Ill.

BY W. W. CALKINS.

Cincinnati Journal of Science, Vol. I, pp. 242-244, 1874.

This paper lists the species of fresh-water shells and adds valuable notes on their habits and variability. The following species are listed:

Limnæa reflexa Say.
*Limnæa zebra** Tryon.
*Limnæa appressa** Say.
Sphærium simile Say.
Sphærium partumeium Say.
Sphærium transversum Say.

Limnæa palustris Müller.
Limnæa caperata Say.
Limnæa umbrosus [*]Say.
Physa gyrina Say.
Physa heterostropha Say.
Planorbis campanulatus Say.
Planorbis trivolvis Say.
Planorbis bicarinatus Say.
Planorbis parvus Say.
Segmentina armigera Say.
Valvata tricarinata Say.
Valvata sincera Say.
Vivipara contectoides W. G. Binney.
Melantho[*] *subsolidus* Anthony.
Melantho[*] *coarctata*[†] Lea.
Bythinella obtusa Lea.
Somatogyrus depressus[*] Tryon.
Amnicola cincinnatiensis Anthony.
Pleurocera subulare Lea.
Goniobasis livescens Menke.
Pisidium abditum Prime.
Pisidium compressum Prime.
Unio cornutus Barnes.
Unio gracilis Barnes.
Unio gibbosus Barnes.
Unio luteolus Lam.
Unio occidens[*] Lea.
Unio rectus Lam.
Unio pustulosus Lea.
Unio pustulatus[†] Lea.
Unio rubiginosus Lea.
Unio elegans Lea.
Unio undulatus Barnes.
Unio verrucosus Barnes.
Unio ellipsis[†] Barnes.
Unio tuberculatus[†] Barnes.
Margaritana complanata Barnes.
Anodonta footiana Lea.
Anodonta imbecilis Say.
Anodonta plana[*] Lea.

3. PAPER BY W. W. CALKINS,

In Valley Naturalist, Vol. I, No. 2, p. 1, Nov., 1878, and Vol. II, p. 53, 1880, published at St. Louis, gives descriptions of the following species from the Chicago area, besides valuable notes:

Succinea calumetensis.
Zonites upsoni.
Amnicola ferruginea.

4. COLLECTING ABOUT CHICAGO.

BY FRANK C BAKER.

Sports Afield, August, 1897, Vol. XIX, No. 2.

The following species are listed from the southern region:

Anodonta footiana Lea.
Unio luteolus Lam.
Unio pustulosus Lea.
Unio gibbosus Barnes.
Sphærium striatinum Lam.
Vitrea arborea Say.
Vitrea indentata Say.
Conulus fulvus Drap.
Pupa contracta Say.
Limnæa palustris Müll.
Limnæa caperata Say.
Limnæa reflexa Say.
Limnæa stagnalis Linné.
Planorbis trivolvis Say.
Planorbis campanulatus Say.
Planorbis parvus Say.
Segmentina armigera Say.
Vivipara contectoides W. G. Binney.
Campeloma decisum Say.
Campeloma subsolidum Anthony.
Pleurocera subulare Lea.

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[*] For the correct position of these names, which are synonymous, the reader is referred to the body of this work.

[†] These species have not as yet been found in the territory under consideration.

5. A Day on the Chicago Drainage Canal.

BY FRANK C. BAKER.

The Nautilus, Vol. XII, No. 6, p. 63, October, 1898.

The following species are enumerated from the western region:

Anodonta grandis Say.
Anodonta imbecilis Say.
Alasmodonta complanata Barnes.
Alasmodonta deltoidea Lea.
Lampsilis luteolus Lam.
Sphærium simile Say.
Sphærium stamineum Conrad.
Calyculina truncata Linsley.
Succinea retusa Lea.
Limnæa desidiosa Say.
Limnæa palustris Müll.
Limnæa caperata Say.
Limnæa humilis Say.
Planorbis trivolvis Say.
Planorbis bicarinatus Say.
Planorbis campanulatus Say.
Planorbis truncatus Miles.
Planorbis deflectus Say.
Physa heterostropha Say.
Aplexa hypnorum Linné.
Goniobasis livescens Menke.
Amnicola limosa Say.
Amnicola lustrica Pilsbry.
Amnicola cincinnatiensis Lea.
Vivipara contectoides W. G. Binney.
Valvata tricarinata Say.

6. A New Sphærium.

BY FRANK C. BAKER.

The Nautilus, Vol. XII, No. 6, p. 65, October, 1898.

Description of *Sphærium lilycashense* Baker, from Lilycash Creek, western region.

7. Notes on the Mollusks of Lilycash Creek.

BY FRANK C. BAKER.

The Nautilus, Vol. XIII, No. 3, p. 30, 1899.

The following species are listed from the western region:

Sphærium staminium Conrad.
Sphærium lilycashense Baker.
Sphærium striatinum Lam.
Sphærium simile Say.
Sphærium occidentale Prime..
*Calyculina transversa** Say.
*Calyculina truncata** Linsley.
Pisidium abditum Haldeman.
Pisidium compressum Prime.
Pisidium walkeri Sterki.
Pisidium cruciatum Sterki.
Pisidium punctatum Sterki.
Pisidium fallax Sterki.
Pisidium splendidulum Sterki.
Pisidium variabile Prime.
Pisidium sp.
Pisidium roperi Sterki.
Limnæa humilis Say.
Limnæa desidiosa Say.
Planorbis parvus Say.
Physa heterostropha Say.
Pleurocera elevatum Say.
Amnicola limosa Say.
Amnicola limosa var *parva* Lea.
Cincinnatia cincinnatiensis Lea.
Pomatiopsis cincinnatiensis Anthony.
Campeloma rufum Haldeman.
(Reversed.)

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*Mr. Handwerk, who sent the specimens for identification, says, in a letter of recent date, that the two *Calyculina* were from the Desplaines River and not from Lilycash Creek.

8. A REVISION OF THE PHYSÆ OF NORTHEASTERN ILLINOIS.

BY FRANK C. BAKER.

The Nautilus, Vol. XIV, No. 2, p. 16, 1900.

The following species are described and figured: *Physa heterostropha*, *P. sayii*, *P. integra*, *P. gyrina*, and variety *elliptica*.

9. A REVISION OF THE LIMNÆAS OF NORTHERN ILLINOIS.

BY FRANK C. BAKER.

Trans. Acad. Sci. St. Louis, Vol. XI, No. 1, pp. 1-24, pl. i, 1901.

All of the species found in the Chicago area are described and figured.

10. NEW VARIETIES OF FRESH-WATER SHELLS.

BY FRANK C. BAKER.

The Nautilus, Vol. XV, p. 17, 1901.
Description of *Limnæa reflexa jolietensis*.

11. DESCRIPTION OF A NEW SPECIES OF LIMNÆA.

BY FRANK C. BAKER.

Bull. Chi. Acad. Sciences, Vol. II, No. 4, p. 229, 1901.
Description of *Limnæa Woodruffi*.

12. LIMNÆA AURICULARIA IN AMERICA.

BY FRANK C. BAKER.

The Nautilus, Vol. XV, No. 5, p. 59, 1901.

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*The writer wishes to express his appreciation of Mr. W. G. Binney's [illegible]raphy of North American Conchology, to which he has made frequent reference. The catalogue of Corbiculidæ of Temple Prime (Amer. Journ. Conch., Vol. V, pt. 2, 1869-70) has also been of great service. The writer would also express his obligations to Mr. Charles W. Johnson, Curator of the Wagner Free Institute of Science, Philadelphia, Pa., and to Mr. George W. Clapp, Pittsburg, Pa., for very valuable assistance in making up this bibliography.

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The principal abbreviations of Society publications, together with the full titles, are as follows:

Amer. Journ. Conch. American Journal of Conchology.

Amer. Journ. Sci. American Journal of Science and Arts.

Am. Nat. American Naturalist.

Ann. N. Y. Lyc. Annals of the New York Lyceum of Natural History.

Ann. Rep. U. S. Geol. and Geog. Surv. Terr. Annual Report of the United States Geological and Geographical Survey of the Territories.

Ann. Soc. Mal. Belg. Annales de la Societe Malacologique de Belgique.

Bost. Journ. N. H. Boston Journal of Natural History.

Bull. Chi. Acad. Sci. Bulletin of the Chicago Academy of Sciences.

Bull. U. S. Geol. Survey. Bulletin of the United States Geological Survey.

Bull. U. S. Geol. and Geog. Surv. Terr. Bulletin of the United States Geological and Geographical Survey of the Territories.

Bull. U. S. Nat. Mus. Bulletin of the United States National Museum.

Bull. Wash. Coll. Lab. Bulletin of the Washburn College Laboratory of Natural History.

Can. Nat. Canadian Naturalist and Geologist.

Cin. Quar. Journ. Sci. Cincinnati Quarterly Journal of Science.

Contr. to Conch. Contributions to Conchology.

Gen. Rec. Moll. Genera of Recent Mollusca.

Geol. Surv. Mich. Geological Survey of Michigan.

Journ. Cin. Soc. N. H. Journal of the Cincinnati Society of Natural History.

Journ. Phil. Acad. Journal of the Academy of Natural Sciences of Philadelphia.

Journ. Portl. Soc. N. H. Journal of the Portland Society of Natural History.

Mal. Blätt. Malakozoölogische Blätter.

Nich. Encycl. Nicholson's Encyclopedia of Arts and Sciences, first edition, 1816; sec. ed., 1818; third ed., 1819. Philadelphia.

Proc. Bost. Soc. N. H. Proceedings of the Boston Society of Natural History.

Proc. Cal. Acad. Sci. Proceedings of the California Academy of Sciences.

Proc. Daven. Acad. Sci. Proceedings of the Davenport Academy of Sciences.

Proc. Iowa Acad. Sci. Proceedings of the Iowa Academy of Sciences.

Proc. Phil. Acad. Proceedings of the Academy of Natural Sciences of Philadelphia.

Proc. U. S. Nat. Mus. Proceedings of the United States National Museum.

Proc. Zoöl. Soc. or P. Z. S. Proceedings of the Zoölogical Society of London.

Quar. Journ. Conch. Quarterly Journal of Conchology.

Trans. Acad. Sci. St. Louis. Transactions of the Academy of Sciences of St. Louis.

Trans. Amer. Phil. Soc. Transactions of the American Philosophical Society, Philadelphia.

Trans. Ill. State Ag. Soc. Transactions of the Illinois State Agricultural Society.

Trans. Wagn. Inst. Sci. Transactions of the Wagner Free Institute of Science, Philadelphia.

Ver. Moll. Vermont Mollusca.

XIII. GLOSSARY.

In the following pages the technical and other terms used in the body of this work are defined. References are also made to illustrations where they will in any way add to the understanding of a word. Terms which are adequately explained in the text are not here included:

Abdominal sac. That portion of the Unionidæ which contains the stomach and to which the gills are sometimes suspended.

Acephalous. Headless.

Acinose. Full of small bulgings; resembling the kernel in a nut.

Aculeate. Very sharply pointed, as the teeth on the radula of some snails.

Acute. Sharp or pointed, as the spire of a shell (pl. xxxv, fig. 1), or the lip of a shell (pl. xxviii, fig. 15).

Acuminate. Long and tapering, as the spire of some shells (pl. xxxii, fig. 3).

Admedian. Next to the central object, as the lateral teeth on the lingual membrane.

Afferent. To bring in; when relating to a vessel or duct, indicating that it brings in its contents.

Alate. Wing-like, as the dorsal part of some Unios (pl. xviii).

Amœboid. Shaped like an Amœba, a small animalcule.

Amorphous. Without distinct form.

Amphibious. Inhabiting both land and water.

Amphidetic. With the ligament on both sides of the umbones.

Analogue. A likeness between two objects when otherwise they are totally different, as the wing of a bird and the wing of a butterfly.

Anastomosing. Coming together.

Annular. Made up of rings.

Anterior. The front or fore end.

Approximate. Near together, as the umbones of some Unios (pl. xxi fig. 1).

Aquatic. Inhabiting the water.

Arborescent. Branching like a tree.

Arched. Bowed or bent in a curve.

Arcti-spiral. Tightly coiled, as some spiral shells (pl. xxx, fig. 7).

Arcuated. Bent in a bow or arched, as the ventral edge of some bivalves (pl. viii, fig. 1).

Asphyxiating. Causing suspended animation; apparent death.

Assimilation. Act of converting one substance into another, as the changing of food-stuffs into living bodies.

Asymmetrical. Not symmetrical.

Atrophied. Wasted away.

Attenuate. Long and slender, as in some shells (pl. xxxv, fig. 1).

Auditory. Connected with the hearing.

Auricled. Eared, or with ear-like appendages.

Basal. The bottom or lower part.

Biangulate. With two angles.

Bicuspid or bicuspidate. Having two cusps.

Bifid. Having two arms or prongs.

Bifurcated. Having two branches.

Bilateral. With two sides.

Bilobed. With two lobes.

Bivalve. A mollusk with two valves or shells, as the Unio.

Branchial. Referring to the lower or ventral siphons in Pelecypods.

Bulbous. Swollen.

Byssiferous. Attached by a byssus, as in some Unios.

Calcareous. Composed of carbonate of lime.

Callosity. A hardened and raised bunch, as the callus on the columella of some shells (pl. xxxv, fig. 9).

Callus. A deposit of shelly matter.

Calyculate. Cup-like, as the umbo when separated from the rest of the shell by a distinct mark, as in Calyculina.

Campanulate. Formed like a bell.

Canaliculate. Resembling a canal, as the deep sutures in some shells (pl. xxxv, fig. 9).

Cancellated. Formed of cross-bars, as the longitudinal and spiral lines which cross in some shells.

Cardiac pouch. Containing the heart and placed near the umbones of the shell.

Carinate. Keeled (pl. xxvi, fig. 5).

Cartilaginous. Like cartilage.

Caudal. Tail-like, or with a tail-like appendage.

Cellular. Made up of cells.

Cerebral. Pertaining to the brain.

Channeled. Grooved or formed like a channel.

Chitinous. Formed of chitin, as the radulæ of snails.

Ciliary. By means of cilia.

Ciliated. Having cilia.

Cilium (plural cilia). A lash; used to designate the hairs on the mantle, gills, etc.

Cirrated. Having movable hairs, as the siphons of Unio.

Clavate. Club-shaped.

Cloacal. Referring to the upper or dorsal siphon in pelecypods.

Coarctate. Pressed together, narrowed.

Compressed. Flattened out, or pressed together, as some bivalves (pl. ix, fig. 2).

Concave. Excavated, hollowed out.

Concentric. From the same center, as the lines of growth on Sphærium, which are parallel with the umbo.

Confluent. To run together, or into something else, as the muscle scars of some Unios (pl. xix, fig. 1).

Conic. Shaped like a cone.

Connective. A part connecting two other parts, as a muscle connecting two parts of the body, or a nerve connecting two ganglia.

Constricted. Narrowed.

Contractile. Capable of being contracted or drawn in, as the tentacle of a snail.

Convex. Bulged out, as the whorls of some snails (pl. xxxvi, fig. 1).

Convoluted. Rolled together.

Cordate. Heart-shaped.

Corneous. Horn-like, as the opercula of some mollusks.

Corrugated. Roughened by wrinkles, as the shells of some Unios (pl. ix, fig. 1).

Costate. Having rib-like ridges.

Crenulate. Wrinkled on the edges.

Crescentic. Like a crescent.

Cylindrical. Like a cylinder.

Decollated. Cut off, as the apex of some shells (pl. xxxvi, figure next to fig. 8).

Decussated. With spiral and longitudinal lines intersecting, as the sculpture of some shells.

Deflexed. Bent downward, as the last whorl in some snails (pl. xxxii, fig. 15).

Dentate. With points or nodules resembling teeth, as the aperture of some snails (pl. xxx, fig. 7).

Denticulate. Finely dentate.

Depressed. Flattened, as the spire in some snails (pl. xxviii, fig. 4).

Dextral. Right-handed (pl. xxxii, fig. 1).

Digitiform. Finger-like.

Dilated. Expanded in all directions, as the aperture of a shell.

Dimorphism. With two forms or conditions.

Dimyarian. Having two distinct adductor muscle impressions or scars, as in Unio.

Diœcious. Having the sexes in two individuals, one male and one female.

Distal. The farthest part from an object.

Discoidal. Shaped like a flat disk (pl. xxviii, fig. 25).

Diverging. Separating from each other, as the cardinal teeth in some Unios (pl. xviii).

Diverticulum. A pouch or hole, as the pouch containing the radula, or that containing the dart in helices.

Dormant. In a state of torpor or sleep.

Dorsal. The back. In bivalves the hinge portion, and in univalves the opposite to the aperture.

Ectocone. The outer cusp on the teeth of the radula.

Edentulous. Without teeth or folds, as the hinge plate in some Unios, and the aperture in some gastropods.

Efferent. Carrying out.

Elliptical. With an oval form (pl. xii, fig. 5).

Elongated. Drawn out, as the spire of a shell (pl. xxxii, fig. 6).

Emarginate. Bluntly notched.

Encysted. Enclosed in a cyst.

Entocone. The inner cusp on the teeth of the radula.

Entire. With even, unbroken edges, as the aperture of some shells (pl. xxvi, fig. 4).

Epiphallus. A portion of the vas deferens which becomes modified into a tube-like organ and is continued beyond the apex of the penis; it frequently bears a blind duct, or flagellum. (Pilsbry.)

Epithelium. All tissues bounding a free surface.

Equidistant. Equally spaced, as the spiral lines on some snail shells.

Equilateral. Equal sided, as in Unio or Sphærium when the umbones are placed in the center (pl. xxvii, fig. 3).

Equilibrating. Balancing equally.

Equivalve. With both valves of the same size and shape.

Eroded. Worn away, as the epidermis on some shells.

Erosive. Capable of erosion.

Escutcheon. The region behind the umbones in opisthodetic pelecypods.

Excavated. Hollowed out, as the columella of some snails (pl. xxxvi, fig. 10).

Excurrent. Referring to the siphon which carries out the waste matter of the body.

Exoskeleton. The outer skeleton; all shells are exoskeletons.

Exserted. Brought out.

Expanded. Spread out, as the lip of some shells.

Falcate. Scythe-shaped.

Fasciculus. A little bundle.

Flagellate. Animals with a flagellum or lash.

Flexuous. Formed in a series of curves or turnings, as the columella in some shells.

Flocculent. Clinging together in bunches. (See anatomical portion for the application of this word.)

Fluviatile. Living in running streams.

Fusiform. Thick in the middle and tapering at each end.

Gelatinous. Like jelly, as the eggs of some mollusks.

Gibbous. Very much rounded, as the whorls in some snails (pl. xxxvi, fig. 1).

Glandular. Like a gland.

Globose. Rounded.

Granulated. Covered with little grains.

Gravid. A female mollusk (as Unio) with ovaries distended with young.

Gregarious. Living in colonies.

Gular. Relating to the windpipe or palate. In mollusks, referring to the innermost part of the aperture.

Habitat. Locality of a species.

Hæmolymph. Molluscan blood.

Heliciform. In form like Helix.

Hemispherical. Half a sphere.

Herbivorous. Subsisting upon vegetable food.

Hermaphrodite. Having the sexes united in the same individual.

Hibernation. The act of hibernating or going to sleep for the winter months.

Hirsute. Covered with hairs, as some snails.

Hispid. Same as hirsute.

Homologous. Having the same position or value, as the wing of a bird and of a bat.

Hyaline. Glassy.

Imperforate. Not perforated or umbilicated (pl. xxix, fig. 3).

Impressed. Marked by a furrow, as the impressed spiral lines on some univalve shells.

Inæquipartite. When one end of a shell is longer than the other, as the two ends in Pisidium.

Incrassate. Thickened.

Incurrent. The siphon in Unio which brings in the food-stuffs.

Incurved. Leaned or bent over, as the apex in some snails.

Indented. Notched.

Inequivalve. When one valve is larger than the other.

Inflated. Swollen, as some bivalve shells (pl. iii, fig. 2).

Inflected. Turned in, as the teeth of some snails.

Inhalent. Same as incurrent.

Inoperculate. Without an operculum.

Intercostate. Between the ribs or ridges.

Invaginate. One part bending into another, as the tentacles of some land snails.

Invertible. Capable of being inverted, or drawn in, as the eye-peduncles of a land snail.

Keeled. With a more or less sharp projection at the periphery (pl. xxvi, fig. 5).

Labial. Pertaining to the lips, as the labial-palpi in Unio.

Lamellated. Covered with scales.

Lamelliform. Having the form of scales.

Laminated. Consisting of plates or scales laid over each other.

Lanceolate. Gradually tapering to a point (pl. xxxii, fig. 3).

Lateral. Pertaining to the side.

Latticed. (See decussated.)

Lenticular. Having the shape of a double convex lens, as some bivalves.

Lithodesma. An accessory shell plate near the umbones, in those shells having a "cartilage" or resilium, as in Mactra.

Lobulate. Composed of lobes.

Longitudinal. The length of a shell.

Lunate. Shaped like a half moon (pl. xxxvi, fig. 7), as the aperture in some shells.

Malleated. Appearing as though hammered (pl. xxxii, fig. 1).

Manducatory. Relating to the apparatus for masticating food. In snails, the jaws and radula.

Marsupium. A part of an animal used as a pouch to contain the young, as the gills of Unio.

Median. Middle, as the middle tooth on the radula.

Mesocene. The middle cusp on the teeth of the radula.

Monœcius. Having the sexes united in the same individual.

Multifid. Made up of many lobes or projections, as the cusps on some radulæ.

Multispiral. Consisting of many whorls, as some fresh-water snails (pl. xxxv, fig. 4).

Nacreous. Pearly or iridescent, as the interior of some Unios.

Nave. The interior coating of Pisidium and Sphærium.

Nepionic. The second stage of the embryonic shell, as the glochidium of Unio.

Nodulosus. Provided with small knobs or projections, as the surface of some Unios (pl. xx, fig. 2).

Notched. Nicked or indented, as the anterior canal of some gastropods (pl. xxxv, fig. 5).

Nucleus. The first part or beginning, as the apex in a univalve and the umbo in bivalves.

Nucleated. Having a nucleus.

Obconic. In the form of a reversed cone (pl. xxxv, fig. 6).

Oblique. Slanting, as the aperture of some shells when not parallel to the longitudinal axis (pl. xxxiv, fig. 7).

Oblong. Longer than high, as some Unios (pl. x, fig. 1).

Obovate. Reversed ovate, as some shells when the diameter is greater near the upper than at the lower part.

Obtuse. Dull or blunt, as the apex of some univalves (pl. xxxv, fig. 9).

Olfactory. Pertaining to the smell.

Olivaceous. Colored like an olive.

Opisthodetic. With the ligament behind the umbones.

Orbicular. Like an orb or disk, as some Sphæria (pl. xxvii, fig. 10).

Organism. An organized being, or living object made up of organs.

Ovate. Egg-shaped.

Ovately conic. Shaped like an egg, but with a somewhat conic apex, as some univalves.

Oviparous. Bringing forth young in an egg which is hatched after it is laid.

Ovisac. A pouch in which the eggs or embryos are contained.

Ovoviviparous. In this case the young are formed in an egg but are hatched inside the parent.

Papillose. Covered with many little bulgings or pimples (pl. xxiv, fig. 2).

Parallel. Having the same relative distance in all parts, as when the spiral lines in univalve shells are the same distance apart all the way around (pl. xxviii, fig. 25).

Parivincular. A ligament "which may be compared to a cylinder split on one side, attached by the several edges, one edge to each valve." (Dall.)

Patelliform. Shaped like a flattened-out cone, as an Ancylus (pl. xxx, fig. 29).

Patulous. Open and spreading, as the aperture in some univalves (pl. xxxiv, fig. 1).

Paucispiral. Only slightly spiral, as some opercula.

Pearly. Having a substance like pearl, as the interior of Unio.

Pectinate. Like the teeth of a comb, as the gills of some mollusks.

Pedal. Pertaining to the foot.

Pedunculated. Supported on a stem or stalk, as the eyes of land snails.

Pellucid. Transparent or clear, as the shells of some snails; e. g. Vitrea.

Penultimate. The whorl before the last in univalve shells.

Pericardium. The chamber containing the heart.

Periostracum. The epidermal covering of some shells, as Succinea.

Pervious. Very narrowly open, as the umbilicus in some snails.

Phytophagus. Vegetable-feeding.

Pilose. Covered with hairs.

Pinnate. Branched like a feather, as the gills of some mollusks.

Plaited. Folded.

Planorboid. Flat and orb-like, as some snails (pl. xxxii, fig. 7).

Pleuræ. Relating to the side of a body.

Plexus. A network of vessels, as the form of the lungs in snails.

Plicated. Made up of folds (pl. xxii, fig. 2).

Plumose. Resembling plumes.

Polygonal. Having many angles.

Porcellanous. Like porcelain.

Post-basal. Beyond or near the base, as the posterio-ventral part of Lampsilis.

Prismatic. Like a prism.

Prodissoconch. The embryonic shell.

Prosodetic. A term applied to the area in opisthodetic ligaments, lying in front of the umbones and forming the lunule.

Protoconch. The embryonic shell.

Protract. To push out.

Protractor pedis. The foot protractor muscle.

Protrusile. Capable of being pushed out.

Proximal. The nearest end of an object.

Pseudocardinals. False cardinal teeth.

Pseudolaterals. False lateral teeth.

Pulsation. A throb, as the throbbing of the heart.

Pupiform. Like a pupa; one of the stages in the development of an insect.

Pustulate. Covered with pustules or little pimples (pl. xxiv, figs. 1, 2).

Pustulose. Same as above.

Pyramidal. Having the form of a pyramid.

Pyriform. Shaped like a pear.

Quadrangular. Having four corners, as some Unios.

Radiated. Extending from a common center, as the rays on some Unios.

Reflected. Bent backward, as the lip in some snails (pl. xxviii, fig. 26), or the cusps in the lingual membrane.

Reflexed. Same as above.

Renal. Relating to the kidneys.

Reticulated. Resembling a network, as when the longitudinal and spiral lines cross in a snail.

Retractile. Capable of being drawn in, as the eye peduncles in land snails.

Retractor pedis. Foot retractor muscle.

Revolving lines. Spiral lines on a snail shell which run parallel with the sutures (pl. xxxv, fig. 5).

Rhombic. Having four sides, the angles being oblique.

Rhomboid. Four-sided, but two of the sides being longer than the others.

Rimate. Provided with a very small hole or crack, as some snails in which the umbilicus is very narrowly open.

Roundly lunate. Rounder than lunate (which see).

Rostriform. In the form of a rostrum.

Rudimentary. Not fully formed; imperfect.

Rugose. Rough or wrinkled, as parts of some shells (pl. ix, fig. 1).

Sacculated. Somewhat like a sac, or composed of sac-like parts.

Scalar. Resembling a ladder.

Schizodont. With few teeth, consisting of one or two cardinals or laterals, as in Unio.

Scutellum. The projecting or pinched parts in front of the umbones in Pisidium.

Scutum. The pinched parts behind the ligament in Pisidium.

Secreted. Produced or deposited from the blood or glands, as the shell material in mollusks.

Semicircular. Half round or circular, as the aperture in some snails.

Semidentate. Half toothed, as the parietal wall in some land snails.

Semielliptic. Half elliptical.

Semiglobose. Half, or not quite globose.

Semilunate. Half lunate.

Semioval. Half, or not quite oval.

Serrated. Notched, like the teeth on a saw.

Serriform. In the form of series.

Sessile. Attached without a stem, as the eyes in some water snails.

Shouldered. Ridged, as the whorls in some snails (pl. xxxv, fig. 9).

Sigmoid. Shaped like the letter S.

Siliceous. Made up of silex.

Sinistral. Having the aperture on the left side (pl. xxxiv, fig. 3).

Sinuous. Curved in and out, as the edge of some bivalves and the lips of some snails (pl. vii, fig. 7; pl. xxxii, fig. 6).

Spatulate. In the form of a spatula, a flat-bladed instrument used by druggists in pulverizing drugs.

Spherical. Shaped like a sphere.

Spiral. Wound about a central cavity, as the whorls of snails.

Striated. Marked by lines or striæ

Subangulated. Moderately angled.

Subcarinated. Moderately carinated.

Subcentral. Not quite in the center.

Subcircular. Not quite circular

Subconical. Moderately conical.

Subcylindrical. Moderately cylindrical.

Subequal. Not quite equal

Subexcavated. A little excavated.

Subfusiform. Moderately fusiform.

Subglobose. Moderately globose.

Subglobular. Moderately globular.

Subhyaline. Moderately glassy

Subimperforate. Not much perforated.

Suboblong. Moderately oblong.

Subobsolete. Almost disappearing.

Subovate. Nearly ovate

Subparallel. Almost parallel.

Subperforated. Almost perforated.

Subquadrate. Almost four-sided.

Subreflected. Moderately turned back.

Subrotund. Moderately round.

Subspiral. Moderately spiral.

Subtriangulate. Moderately or almost triangular.

Subtrigonal. Moderately three-angled.

Subtruncate Moderately cut off.

Subumbilicated. Moderately umbilicated.

Sulcated. Grooved.

Sulcus. A longitudinal furrow.

Superanal. Above the anus.

Supra-peripheral. Above the periphery.

Symmetrical. Alike on both sides or uniform in all parts.

Symphynote. Having the posterio-dorsal portion of the shell flattened and produced, as in Symphynota complanata.

Terrestrial. Living on the land.

Testaceous. Composed of shelly matter.

Torsion. A twisting around.

Tortuous. Twisted or winding.

Torpid. Half unconscious or asleep, as a snail during hibernation.

Translucent. Not quite transparent; light is seen through the thin edges of the object.

Transparent. Objects may be seen through the substance.

Transverse. Referring to the form of a shell when it is wider than high.

Tricuspidate. Having three cusps.

Trifid. Having three branches.

Trigonal. Having three angles.

Trilobate. Having three lobes.

Tripartite. Divided into three parts, as the foot of some snails.

Truncate. Having the end cut off squarely, as some Unios (pl. xiv, fig. 1).

Tuberculate. Covered with tubercles or rounded knobs (pl. xiv, fig. 1).

Turbinate. Having the form of a top.

Turriculated. Having the form of a tower.

Turreted. Having the form of a tower.

Umbilicated. Having an opening in the base of the shell (pl. xxviii, fig. 21).

Undulated. Having undulations or waves, as the surface of some Unios (pl. xxii, figs. 1, 2).

Univalve. Having the shell composed of a single piece, as a snail.

Varicose. Swollen or enlarged.

Vascular. Containing or made up of blood vessels.

Vermiform. Formed like a worm.

Ventral. The lower border or side.

Ventricose. Swollen or inflated on the ventral side.

Vibratile. Moving from side to side.

Vitreous. Resembling glass, as some snails.

♂ Male. The astronomical sign for the planet Mars.

♀ Female. The astronomical sign for the planet Venus.

APPENDIX.

The following pages include a number of species which have been added to our fauna since the foregoing pages were put in print. Several of these are old species recorded for the first time within the limits of the area, while others are new species recently discovered. Several additions and corrections are also made to the introductory and other portions of Part I.

The writer is indebted to the following persons for additional information: Dr. W. H. Dall, United States National Museum, Washington, D. C.; Mr. George H. Clapp, Pittsburg, Pa.; Mr. Bryant Walker, Detroit, Mich.; Mr. Edward W. Roper, San Diego, Cal. (now deceased).

p. 11. Lower part of page. The last sentence should be changed so as to read: "In all groups except the Pelecypoda the mouth is provided with a manducatory apparatus (odontophore, radula or tooth-bearer").

p. 12. The sentence stating that "the subkingdom is of quite recent date geologically" should be changed to read, "is geologically of very ancient date," as the Mollusca are known as far back as the Cambrian.

p. 16. *Planorbis bicarinatus* has been found in the North Branch of the Chicago River by Mr. Jensen, thus bringing it in the northern region.

p. 18. *Lampsilis parvus* has been found in the North Branch of the Chicago River and in the Little Calumet River, and hence belongs to the three regions of the area. *Calyculina transversa* has also been found at Edgebrook and at Blue Island, and belongs with the universally distributed species. *Alasmodonta rugosa* has been found in the North Branch of the Chicago River, and should be placed among the species common to all regions. The following species are to be added to the universally distributed species:

Alasmodonta deltoidea. North Branch Chicago River and Edgewater.

Polygyra monodon. Wolf Lake.

Polygyra leaii. Evanston, Bowmanville, Edgebrook, etc.

Bifidaria armifera. Edgebrook.

Circinaria concava. Wolf Lake, Hammond, Roby, etc.

Planorbis deflectus. Bowmanville.

Planorbis bicarinatus. Edgebrook, Avondale, Lincoln Park, etc.

Somatogyrus subglobosus. Lincoln Park.

Valvata sincera. Maywood, Riverside and Salt Creek.

p. 33. ECONOMY OF THE MOLLUSCA. *Leucochila fallax* SAY has been found injurious to the strawberry, eating the stems and crowns, rasping off the outer coating (epidermis) and sucking the juices, thus causing the fruit to decay. Several thousand specimens were picked from a patch of strawberries, and forty specimens were found upon one plant.*

p. 34. Under STATISTICS. No. 4. Comparison with Pennsylvania. Mr. Clapp writes the author that the number of species quoted from Allegheny County, Pa., is much too small. Mr. Clapp has very kindly forwarded a complete list of the Mollusks of Allegheny County, and the figures on page 34 must be changed to read as follows: families, 23; genera, 46; species, 131; varieties, 4.

p. 54. *Anodonta footiana* is now considered a variety of *Anodonta grandis*.

p. 57. *Alasmodonta rugosa* Barnes should now be called *Symphynota costata* Rafinesque (Ann. Gen. Sci. Brux., Vol. V, p. 318, pl. lxxxii, figs. 15, 16, 1820); vide Simpson.

p. 58. *Alasmodonta pressa* should be called *Symphynota compressa* Lea.

p. 60. *Alasmodonta complanata* should be called *Symphynota complanata*. *Alasmodonta* should be changed to *Alasmidonta*, as spelled by Say in Journ. Phil. Acad., Vol. I, p. 459, 1818.

p. 62. *Alasmodonta marginata* Say should be changed to *Alasmidonta truncata*, B. H. Wright. (See The Nautilus, Vol. XI, p. 124, 1898.) The true *marginata* is confined to the Atlantic drainage.

p. 63. *Alasmodonta deltoidea* should be called *Alasmidonta calceola*, the reference being Trans. Amer. Phil. Soc., Vol. III, p. 205, pl. iii, fig. 1, 1830.

p. 71. *Unio hildrethianus* Lea should be changed to *Hemilastena ambigua* Say. The genus *Hemilastena* (Agassiz, 1852) Simpson, differs from Unio in the sculpture of the umbones and in the teeth. The gills are united to the mantle posterior to their ends. The name *ambigua* was used by Say in Journ.

*Vide F. T. Cox, in the Amer. Nat., Vol. II, No. 12, p. [illegible], Feb., 1869.

Phil. Acad., Vol. V, p. 131, 1825, and must displace that of Lea published in 1834.

p. 71.

11a. Unio gibbosus delicatus Simpson, pl. xv, figs. 2, 4.

Unio gibbosus var. *delicatus* SIMPSON, Proc. U. S. Nat. Mus., Vol-XXII, p. 704, 1901.

Differs from typical *gibbosus* in being thin, greatly compressed and with an evenly elliptical outline and very dark nacre.

p. 74. *Anodontoides subcylindraceus* is a variety of *ferussacianus.*

p. 79. *Quadrula coccinea* should be credited to Conrad, who described it in his monograph, p. 29, pl. xiii, fig. 1, in 1836. Lea's name not appearing until June 15, 1838. (Vide Simpson, in letter.)

p. 80. *Quadrula plicata* Lesueur should be credited to Say, who really described the species. (*Unio plicata* Say, Nich. Encyc., Vol. II, pl. iii, fig. 1, 1816.)

p. 85. *Quadrula verrucosa* Barnes should be called *Quadrula tuberculata* Rafinesque, the reference being *Obliquaria* (*Rotundaria*) *tuberculata* RAF., Ann. Gen. Sci. Brux., Vol. V, p. 103, 1820.

p. 100. The following species is distinct from *anodontoides*, which is figured on plate x, figs. 1, 2.

150. Lampsilis fallaciosus (Smith) Simpson, pl. x, fig. 3.

Lampsilis fallaciosus SMITH, Bull. U. S. Fish Com., 1899, p. 291, pl. lxxix.

Figured and name given, but not described nor authority given.

Lampsilis fallaciosus (Smith) SIMPSON, Proc. Phil. Acad., p. 74, pl. ii, fig. 5, 1900.

"Shell elongate elliptical, subsolid, inflated, rounded in front, and ending in a rather sharp point behind, at two-thirds the height of the shell, with a moderate, rounded posterior ridge; beaks not prominent, their sculpture consisting of a few delicate parallel ridges, somewhat doubly looped, the hinder loops generally open behind; epidermis very smooth and shining, ashy straw color, often brownish on the back of the shell, generally feebly rayed with green; female shell decidedly swollen in the postbasal region, so that the base line is often incurved in front of the swelling; teeth rather delicate, there being one compressed pseudo-cardinal and one lateral in the right valve, and two pseudo-cardinals and two laterals in the left; beak cavities not deep; nacre brilliant, silvery."

"Length, 90; height, 40; diameter, 32 mill."

"Upper Mississippi drainage; south to the Cumberland and Arkansas rivers; Red River of the North."

"This species has generally been confounded with its near ally, *Lampsilis anodontoides* Lea. It is a smaller, more inflated, and in every way a more delicate form than the latter, is not so high, the epidermis is brighter and more glossy, and generally rayed. The postbasal inflation of the female is usually more pronounced, and the posterior point is higher than in *anodontoides*. The latter is usually more yellow or tawny than *fallaciosus*, and is, on the whole, a heavier shell."

"In *L. fallaciosus* there is a horny, brown, raised streak on the inside of the mantle behind, that I do not find in *anodontoides*, and the palpi of the former are shorter." (Simpson.) It is confined to the western region, and has been collected only in Hickory Creek, near Joliet

p. 106. *Lampsilis spatulatus* Lea should be called *Lampsilis ellipsiformis* Conrad (*Unio ellipsiformis* CONRAD, Monograph, Vol. VIII, p. 60, pl. xxxiv, fig. 1, 1836).

p. 109. *Lampsilis parvus* Barnes. This species has been found in the Little Calumet River and is abundant in a creek near Blue Island. Mr. Jensen has given the following measurements of a specimen in his collection: length, 41.00; height, 24; breadth, 19.50 mill.

p. 113. Species No. 37 should be changed as follows:

37. **Sphærium vermontanum** Prime, pl. xxvii, fig. 4.

Sphærium vermontanum PRIME, Proc. Phil. Acad., p. 128, 1861.

Shell: The description on pages 113 and 114 holds good. The following additional measurements have been made:

Length, 12.00;	height, 10.00;	breadth, 7.00 mill.	(Lyon coll.)
" 11.50;	" 9.00;	" 6.50 "	" "
" 11.50;	" 9.00;	" 7.50 "	" "
" 13.50;	" 10.50;	" 8.00 "	" "

Animal: Not observed.

Distribution: Lakes Champlain and Memphremagog, Vermont (Prime); Shoreham, Vt., and Holland, Mich. (E. W. Roper, in letter); Michigan (Bryant Walker, after De Camp); Lake Michigan, at Miller's, Ind., and Chicago, Ill. (Dr. H. N. Lyon); Hickory Creek (J. H. Ferriss).

Geological distribution: Pleistocene.

Habitat: Found generally in the larger lakes.

Remarks: This species was at first identified as *solidulum* Prime, but specimens submitted to Mr. E. W. Roper, a short time before his death, were pronounced by him to be *vermontanum*. It is one of the commonest Sphæria found in the area, ranking next to *fabale* in this respect. It is easily distinguished from the related species by its triagonal form and less distinctly marked umbones.

p. 113 et al. All references to *solidulum* should be changed to *vermontanum.*

p. 114.

38. **Sphærium stamineum** Conrad.

This species is very common in Lilycash Creek, near Joliet, Ill., where it has been collected by Mr. J. H. Handwerk. The specimens from this locality are very variable, some being typical in form, yellowish in color and with the ends of the shell broadly rounded, while others are very dark horn color, the ends more rounded, and the ventral part more regularly inflated; the umbones are more coarsely sulcated. Some specimens from this locality have a wholly inversed hinge. *S. striatinum* and *S. simile* have also been found in large numbers in Lilycash Creek.

p. 117. After *S. simile* add the following:

151. **Sphærium lilycashense** Baker. Text figure 137.

Sphærium lilycashense Baker, The Nautilus, Vol. XII, No. 6, p. 65, Oct., 1898.

Shell: Of good size, inflated, rather solid, although not so solid as either *staminium*, *striatinum* or *simile*, subequilateral, indistinctly quadrangular; umbones slightly elevated, well rounded, a little anterior of the center of the shell, marked by numerous rather heavy ridges, the beaks closely approximate; dorsal and ventral margins slightly curved; anterior end rounded, posterior end very broadly rounded; umbonal slopes very much rounded; surface shining, growth lines numerous, coarse, closely set; color varying from light yellowish horn to rather dark horn, with an occasional zone of yellowish; ligament weak, light brownish in color; cardinal teeth small, similar in shape and position to those of *striatinum;* lateral teeth quite solid, double in the right and single in the left valve, short, lamellar, nearly straight, the single left valve teeth much more elevated than the double right valve teeth; muscle scars and pallial line faintly visible; nacre bluish, the portion near the umbones transparent; cavity of the beaks rather deep.

Length,	14.00;	height,	11.00;	breadth,	8.50 mill.
"	13.00;	"	10.00;	"	8.00 "
"	12.50;	"	9.75;	"	7.50 "

Animal: Not examined.

Distribution: Lilycash Creek, near Joliet. (Collected by J. H. Handwerk.)

Geological distribution: Unknown.

Habitat: In a small creek, in soft mud.

Remarks: This variety was referred to Dr. V. Sterki by Mr. Handwerk, and considered by him to be an unusual form of *striatinum*, but he did not consider it distinct from the typical form. After examining a large number of specimens, the writer has concluded that it is a form distinct enough for a specific name. Its beautiful polished surface and inflated shell will at once distinguish it from *striatinum*. It is shaped differently from *stamineum* and the beak sculpture is very much finer.

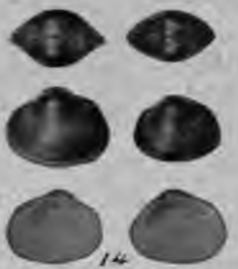

FIG. 187.
SPHÆRIUM LILYCASHENSE Baker. Natural size.

Another form is found associated with the variety which is in a sense intermediate between the typical form and the variety, having a more oval shell than the type, but not being so much inflated; it is very dark chestnut or dark brown in color. Several specimens of this form had the hinge wholly or partly inverse.

p. 120.

43. **Calyculina transversa** Say.

This species has been found abundantly in the Desplaines River (J. H. Handwerk), and in Lake Michigan (Dr. H. N. Lyon).

p. 126.

47. **Pisidium abditum** Haldeman.

This species has been found in large numbers in Lilycash Creek and at Smith's Bridge, eleven miles southwest of Joliet.

The specimens from these localities are exceedingly variable as to size, shape, color, shape of beaks, etc. (vide Sterki).

p. 127.

48. **Pisidium virginicum** Gmelin (not Bourguignat).

Large specimens of this species have been collected in Lilycash Creek.

Length, 7.50; height, 6.00; breadth, 4.50 mill.
" 7.00; " 5.50; " 4.50 "
" 8.50; " 7.00; " 5.50 "

p. 128.

49. **Pisidium compressum** Prime.

This species has been found abundantly in Lilycash Creek and a few specimens in Lake Michigan. Dr. Sterki says that it varies very much in size, shape, prominence of beak, and in their ridges, striation, etc.

p. 129.

50. **Pisidium politum** Sterki, pl. xxxi, fig. 13.

Dr. Sterki has very kindly forwarded figures of this species. He also remarks that the specimens from Joliet are the most beautiful ones he has thus far seen.

The following species have been described or collected since the publication of Part I:

152. **Pisidium variabile** Prime, pl. xxxi, fig. 19.

Cyclas nitida MIGHELS, Linsley, Amer. Journ. Sci., Vol. XLVIII, p. 276, 1845.
Pisidium variabile PRIME, Proc. Bost. Soc. N. H., Vol. IV, p. 163, 1851.
Pisidium grande WHITTEMORE, in litt., 1855. (vide Prime).

Shell: Small, solid, inflated, inequilateral, oblique; umbones very much elevated; full, very prominent, placed posteriorly, smooth and polished to the naked eye but marked by fine lines when viewed with a lens; all margins rounded, the anterior being somewhat pointed or triangular and quite long, while the posterior is short and very broadly rounded; umbonal slopes rounded, the anterior subexcavated; surface shining, marked by rather heavy, regular growth lines; color varying from light yellow or straw to greenish or brownish, with a zone of light or dark color near the ventral margin; in some specimens two zones are present, while in others the zone is hardly visible; ligament small and weak; cardinal teeth small, a single long, arched tooth in the right valve, and two more or less pyramidal teeth in the left valve; the right valve tooth is constricted in the center of the arch and gradually enlarges toward the distal end of the arch, the right arm of arch being the longer and reaching nearly to the base of the hinge plate; the upper left valve tooth is somewhat gourd-shaped, beginning small at the upper margin of the hinge plate and gradually enlarging to about the center of the plate; the lower left valve tooth is large, solid and pyramidal; lateral teeth elevated above the valve edge, triangular; the entire hinge plate about the lateral teeth is enlarged, thick and heavy; cavity of the beaks deep and full; nacre bluish-white, shining.

Length, 4.50; height, 4.50; breadth, 3.10 mill.
" 4.00; " 4.00; " 3.00 "

Animal: Not observed.

Distribution: New England west to Washington, Michigan south to Virginia and Kansas.[*]

Geological distribution: Pleistocene; Loess.

Habitat: In soft mud in creeks, rivers and lakes.

Remarks: *Variabile* does not appear to be common in this region, although it has been found rather widely distributed, specimens having been collected in Lake Michigan, Lilycash Creek, Du Page River and Rock Run. It is therefore found in the southern and western regions. It is quite a distinct shell, distinguished from *compressum* by its less trigonal form, and being more oblique than *virginicum*. Some specimens are higher than others and in this form approach *compressum*.

3. **Pisidium cruciatum** Sterki, pl. xxxi, figs. 20, 21.

Pisidium cruciatum STERKI, The Nautilus, Vol. VIII, p. 97, pl. ii, figs. 1-6, 13, 13a, 1895.

Shell: "Minute, inequipartite, oblique, subtriangular in outline, high, ventricose, regularly and comparatively coarsely striated, straw-colored; anterior part moderately long with an oblique, nearly straight edge above and the end rounded; posterior part short, the end somewhat obliquely truncate, superior margin rather strongly curved, scutum scarcely, scutellum little marked, the latter forming a rather distinct angle; inferior part moderately curved; beaks prominent, each with two ridges diverging at nearly right angles, together forming a cross on the upper aspect of the shell, each of the ridges ending in a nodule of which the posterior is larger and more prominent; nave rather thick, whitish; hinge very stout, list strong; cardinal teeth rather large, and strongly projecting inward from the hinge list; in the right valve one, strongly curved, posterior part thick, anterior thin, lamellar, the ends united by a lamella so as to form a deep groove into which the posterior tooth of the left valve articulates; in the left valve two, the posterior (inferior) stout, massive, the other, superior and a little anterior, rather short, fine, lamellar, oblique, little curved; lateral teeth large, high and pointed in the left, strongly projecting inward in the right valve, the latter with no (or only traces of) outer teeth, and a deep groove; between the cardinal and the lateral teeth the hinge-list is rather deeply excavated, so that all teeth are markedly isolated; muscle insertions visible; ligament short, strong." (Sterki.)

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[*] The writer has not been able to satisfactorily trace the distribution of this species in the South.

Length, 1.90; height, 1.90; breadth, 1.40 mill.
" 2.10; " 2.10; " 1.60 "
" 1.70; " 1.70; " 1.30 "

Animal: "Soft parts slightly yellowish." (Sterki.)

Distribution: Tuscarawas River, New Philadelphia, Ohio (Sterki); Joliet, Ill. (Ferriss); Lilycash Creek (Handwerk).

Geological distribution: Pleistocene; Lower Loess of Illinois. (Sterki.)

Habitat: "Living in mud among aquatic plants and dead leaves, and as a rule covered with a black or brown coat, sometimes so thick that they appear to be globules of dirt." (Sterki.)

Remarks: "The singular shape of the umbones is so characteristic that this species will be recognized at once, and cannot be mistaken for any other. And also in the formation of the hinge it is quite unlike any other Pisidium, so that it holds a peculiar position in the genus. In the hinge structure it is very illustrative and instructive for the understanding of the different forms of teeth." . . . .

"Our species is rather variable, even so that all specimens from one place in the river are different in size and shape from those of another place scarcely half a mile distant. It measures from 1.60 to 2.10 mill., 1.90 being about the average; the margins may be rather obtuse or somewhat acute, the beaks more or less prominent, and the anterior nodule more or less marked. As a rule there are no outer lateral teeth in the right valve, yet traces of them may be seen in some specimens. Also in the formation of the cardinal teeth there is some variation, as the one in the right valve may be indented in its middle at the angle, and so there are apparently two teeth." (Sterki.)

154. **Pisidium splendidulum** Sterki, pl. xxxi, fig. 23.
Pisidium splendidulum STERKI, The Nautilus, Vol. XI, p. 113, 1898.

Shell: "Mussel small, well inflated, rather ovoid in outline, scutum and scutellum rather well marked, the former often prominent; beaks slightly posterior, somewhat prominent, moderately large, rounded; color pale to deep horn, surface polished, with very fine, somewhat irregular striæ; shell thin, transparent; hinge rather fine but well formed, plate narrow; cardinal teeth longitudinal, lamellar, the right one rather long, slightly curved, most so at both ends, more or less thickened at the posterior end, and often with a groove; the two in the (left) valve nearly equal, parallel, little curved, the superior is anterior for about one-third of its length; lateral teeth comparatively strong, all projecting into the interior of the mussel, pointed; ligament rather long." (Sterki.)

Length, 2.80; height, 2.40; breadth, 1.70 mill. (Sterki.)

Animal: Unknown.

Distribution: Caribou, Saco and Old Orchard, Maine; Grand Rapids, Mich.; Washington, D. C.; Virginia, near Washington (Sterki); Lilycash Creek, near Desplaines River, Illinois (Handwerk).

Habitat: In creeks, brooks and rivers, buried in soft mud.

Remarks: "Our species cannot be mistaken for any other Pisidium. In shape it has some resemblance with *P. abditum* and *politum;* but its small size, the color and transparency of the shell, and the shape of the cardinal teeth, will readily distinguish it. In size, color and transparency of the shell, and the polished surface, it resembles *P. ventricosum* and *vesiculare;* but both the latter are much more inflated, their beaks are quite posterior and larger. It is, however, rather variable in size and coloration, and in the striation of the surface." (Sterki.)

This new species is very common wherever it has been found in the Eastern states, and it may be looked for in considerable quantities in our Western states.

155. **Pisidium fallax** Sterki, pl. xxxi, fig. 16.
Pisidium fallax STERKI, The Nautilus, Vol. X, p. 20, 1896.
Pisidium fallax var. *septentrionale* STERKI, The Nautilus, Vol. XII, No. 7, p. 78, 1898. (non Prime.)

Pisidium fallax var. *boreale* STERKI, The Nautilus, Vol. XIII, p. 12, 1899.

Shell: "Mussel rather small; it is of the same type with *P. compressum* Prime, but smaller, more rounded in outline, the upper margin is less strongly curved, not angular, the ridges on the beaks are comparatively larger and situated less high up; the striation is finer, crowded, somewhat irregular and sharp; the color commonly greenish or yellowish-horn in the younger, more yellow in older specimens; the hinge is strong, more regularly curved than in *compressum*, the hinge plate broad, the cardinal tooth of the right valve more oblique, the lateral teeth strongly projecting inward; nacre more glassy-whitish; ligaments strong." (Sterki.)

Length, 3.20; height, 2.90; breadth, 2.10 mill.

Animal: Unknown.

Distribution: Tuscarawas River and Sugar Creek, Ohio (Sterki); Joliet, Ill. (Ferriss); Lilycash Creek, Ill. (Handwerk); Wisconsin, Michigan, Maine (Sterki).

Habitat: Found in company with *P. compressum* and *cruciatum*.

Remarks: This is a distinct little species. Dr. Sterki says it has been found in the stomach of the fish known as "Buffalo Sucker," with *P. cruciatum* and other shells. "Old specimens of *P. fallax* are almost always badly eroded, and covered with a thick, blackish coat, while *Pis. compressum* from the same places were intact and clear." (Sterki.)

This species is common about Joliet, but has not been found in any other part of the area. Specimens of *compressum* should be carefully compared with the above description to separate the two species.

156. **Pisidium walkeri** Sterki, pl. xxxi, fig. 15.

Pisidium walkeri STERKI, The Nautilus, Vol. IX, p. 75, 1895.

Pisidium walkeri var. *mainese* STERKI, l. c., Vol. XII, p. 79, 1898.

Shell: "Mussel of medium size, elongated, rather inflated, resembling *P. abditum*, but is smaller than good-sized examples of that species; it is also more elongated, and the smaller and moderately prominent beaks are more posterior; thus the anterior part is comparatively long, with the end rounded, the posterior quite short, truncated at the end; scutum and scutellum well marked. The shell is very thin, translucent, the surface very finely, and sharply striated, often somewhat scaly, dullish, or with a silky gloss; color grayish, along the margin more or less yellowish-horn. Hinge moderately strong, of the same type as in *Pis. abditum;* cardinal tooth of the right valve moderately curved, its posterior part thickened and with a deep furrow; below this tooth, there is a deep groove formed by the inferior edge of the hinge list raised; and the same formation is in the left valve below the deep groove between the two cardinal teeth; ligament comparatively strong." (Sterki.)

Length, 4.50; height, 3.70; breadth, 2.80 mill.

"In outline our species has some resemblance with *P. virginicum*, by its elongate shape, the beaks situated posteriorly, the long and below somewhat sacciform anterior part. But it is much smaller, its shell quite thin, the hinge finer, the striation finer, and the beaks are much smaller." (Sterki.)

Animal: Not known.

Distribution: Northeastern Maine (Nylander); Kent County, Utica, Grand Rapids, Mich.; Columbia, Pa.; Mohawk, N. Y.; Clearwater and Mississippi rivers, Minn. (Sterki); Du-Page River, Ill. (Ferriss); Lilycash Creek, Ill. (Handwerk); Francis Creek, Joliet (Ferriss).

Geological distribution: Pleistocene; Loess.

Habitat: Found on a muddy bottom in company with *P. compressum* and *P. abditum.*

Remarks: This is a rare species and has been found only in the western region. It may be looked for from both southern and western regions.

157. Pisidium scutellatum Sterki, pl. xxxi, fig. 14.

Pisidium scutellatum STERKI, The Nautilus, Vol. X, No. 6, p. 66, Oct., 1896.

Shell: "Mussel of medium size, rather high, oblique, markedly protracted downward in its anterior part, well rounded, rather strongly inflated; beaks much posterior, rather large, prominent, rounded; superior margin short, little curved, or almost straight, scutum and scutellum well marked, forming projecting angles; the other margins well curved, or the posterior very slightly truncated, anterior end well rounded, or with a slight indication of an angle; surface polished, with irregular striæ and some coarse lines of growth; shell thin, transparent, of a yellowish-horn to amber color, often grayish or brownish-horn in older specimens, and whitish on the beaks; nacre glassy, inner surface microscopically rugulose; hinge fine, short, cardinal teeth lamellar, the one in the right valve moderately curved, its posterior end thicker; the inferior in the left valve curved, the superior little so or almost straight; lateral teeth very short, very abrupt, pointed, thin, little projecting into the cavity of the mussel; ligament small. (Sterki.)

Lgth., 4.00; height, 3.60; breadth, 2.80 mill.
" 3.30; " 2.80; " 2.40 " or less (deep water form). Sterki.

Animal: Not examined.

Distribution: "Pine Lake, 5–11 meters; Lake Michigan, off New York Point, 24 meters; also taken from the stomachs of whitefish of Lake Michigan; various parts of Michigan and Minnesota" (Sterki); Lake Michigan near Chicago (Baker); Huntley, Ill. (Ferriss). "Sterki says of these specimens that they are smaller and much less full than the typical examples from Lake Michigan" (in letter).

Geological distribution: Pleistocene.

Habitat: Collected at considerable depths in the larger lakes, and in numerous small lakes and rivers.

Remarks: "This is one of our most characteristic Pisidia, distinguished, besides its surface features, color, and the configuration of the hinge, by its oblique shape and the much larger anterior part. This character it has in common with *Pis. virginicum* Gmel. and *walkeri;* the former of these is out of the question; the latter species is much more angular and the surface dull, from microscopic lamellæ, but even."

"*Pis. scutellatum* is somewhat variable; the largest specimens seen, from Orchard Lake, Mich., are 4.5 mill. long. Those from deep water are the smallest and most inflated, and their beaks are commonly more prominent; some of them have crowded striæ of growth." (Sterki.)

The specimens from Chicago were found in drift along the lake shore at Miller's, Ind., and were probably washed up from deep water.

158. **Pisidium punctatum** Sterki, pl. xxxi, figs. 17, 18, 22.

Pisidium punctatum STERKI, The Nautilus, Vol. VIII, No. 9, p. 99, Jan. 1895.

Shell: "Minute, inequipartite, high, oblique, strongly ventricose, almost globular, regularly and sharply striated, microscopically rugulose, whitish; anterior part moderately long, the edge above oblique, almost straight, end slightly angled, rather inferior; anterior part short, truncate, slightly angular above, rounded below; superior and inferior margins moderately curved, the former rather short, the latter long; scutum little, scutellum moderately marked, both forming slight angles; vertical section heart-shaped, horizontal, short, lanceolate-rhombic; margins very slightly acute; beaks moderately full and prominent, with a longitudinal, slightly oblique ridge (sometimes obsolete) below the culmination; nave moderately thick, whitish, with crowded, small pits, from which it appears as if dotted; hinge moderately strong; cardinal teeth fine, in the left valve two, lamellar, longitudinal, about equally long, a little curved, almost parallel, the upper little anterior; in the right valve one, longitudinal, little curved, lamellar, the posterior end slightly thickened; lateral teeth rather small and thin, in the left valve one, pointed, in the right valve two, the outer quite small; hinge-list fine, rather regularly formed; ligament rather long and fine." (Sterki.)

Length, 1.80; height, 1.60; breadth, 1.30 mill. (Sterki.)

Animal: "Soft parts colorless, rest whitish." (Sterki.)

Distribution: "Ohio; Tuscarawas River, Bear Run, tributary to the Mahonig River, Portage County, a spring brook at Rootstown Station, Portage County, emptying into Cuyahoga River (Lake Erie and St. Lawrence drainage) (Sterki); Lilycash Creek, near Joliet, Ill. (Mississippi drainage) (Handwerk).

Geological distribution: Pleistocene: Loess.

Habitat: In creeks, pools and rivers.

Remarks: "This species resembles somewhat *Pis. compressum* Prime, in having a ridge or appendage, but not in the same place, as it stands on the outside, below the culmination of the beaks, while in the mature *P. compressum* it has its place rather on top. The shape of the shell is different and the size is very much smaller, its bulk being only about one-tenth of that shell. And while the upper part of the posterior margin in *P. compressum* is rounded or flattened, it is sharp, somewhat "pinched" in *P. punctatum.* In this the shell is purely whitish, or light straw-colored, the latter more so when dry, while the mature *P. compressum* is always more or less grayish. A marked feature is the finely and densely pitted interior surface of the shell, the dots being distinctly perceptible through the shell from the outside. Yet this is not unique, as I have also seen it in other Pisidia. Some specimens show not a trace of the appendages on the beaks, yet they are evidently identical." (Sterki.)

This Pisidium is not common in this area, and only a few specimens have been found in Lilycash Creek, near Joliet, (western region) by Mr. Handwerk. Further search will probably bring more to light, not only in that locality, but in others. Heretofore it has been found only in the Ohio and St. Lawrence drainages, but we must now add the drainage of the Mississippi.

159. **Pisidium roperi** Sterki. Unfigured.

Pisidium roperi STERKI, The Nautilus, Vol. XII, No. 7, p. 77, Nov., 1898.

Shell: "Mussel rather large, strongly inflated when mature, very little so when young; oblong to ovoid in outline, margins regularly curved with no projecting angles (in the adult); scutum and scutellum scarcely marked; beaks moderately posterior, very broad, surface somewhat glossy, with irregular, not sharp, striæ and some strongly marked lines of growth; color of the dry shell straw to yellowish-horn, often with one to seven fine, concentric lines of purple; shell rather thin, nacre whitish, muscle insertions scarcely marked, hinge comparatively fine and short; cardinal teeth quite small, the right one moderately curved, slightly thickened at the posterior end; the left ones very short; the inferior slightly angular, truncated or pointed on top, the superior sometimes almost obsolete; lateral teeth short, small, scarcely projecting into the interior; ligament rather fine." (Sterki.)

Length, 5.50; height, 4.40; breadth, 3.80 mill. (Sterki.)
" 4.50; " 3.70; " 3.00 " "

Animal: "Soft parts pink, especially so the foot and mantle edges; the living mussel appears pale red, but the color soon fades away after the death of the animal; it is also very pale, scarcely noticeable in the young, becoming more intense with the age of the animal." (Sterki.)

Distribution: "Maine, Rhode Island, Indiana, Illinois and Minnesota; probably also Utah, California and Washington." (Sterki.)

Geological distribution: Pleistocene; Loess?

Habitat: "The largest and most beautiful specimens were collected in Higginbotham's Spring, near Joliet, Ill., by Messrs. J. H. Ferriss and J. H. Handwerk." (Sterki.)

Remarks: "*Pis. roperi* cannot be mistaken for any other species, except some forms of *P. abditum* Hald.; but it is at once distinguished from the latter species by its comparatively very broad beaks, the more elongated and more regular outline, the different appearance of its surface, usually the lighter color, the comparatively fine and shorter hinge, and, in the living animal, by the pink color of the soft parts shining through the shell. It is the only species in which that color has been noticed so far, yet it remains to ascertain whether this be a constant character. But, however that may be, the species is valid. From several places specimens were obtained in company with *P. abditum*, and at once recognized as distinct." (Sterki.)

Thus far this species has been found in this area only at Higginbotham's Spring, near Joliet, in the western region. Additional localities will undoubtedly be found when the streams and springs are more carefully searched.

160. **Pisidium handwerki** Sterki. Unfigured.
Pisidium handwerki STERKI, The Nautilus, Vol. XIII, p. 90, 1899.

"Mussel small, rather rounded in outline, rather high, moderately inflated; beaks moderately large, somewhat papilliform; superior margin strongly, inferior moderately curved; posterior rounded or slightly truncated, anterior end rounded or with a slight indication of an angle; surface with dense, almost regular and sharp striæ, and with a silky gloss, tops of beaks smooth and shining, slightly flattened; color of epiconch pale to yellowish-horn; shell rather strong, nacre colorless or whitish, hinge stout, strongly curved, plate moderately broad, lateral teeth stout, rather high, short; cardinal teeth small, fine; the right one angular, with the posterior part somewhat thicker, inserted in a longitudinal groove on the hinge plate; posterior cardinal tooth of the left valve rather long, longitudinal, nearly straight, its ends sloping; anterior oblique, quite small or almost obsolete; ligament rather small." (Sterki.)

Length, 2.40; height, 2.20; breadth, 1.70 mill. (Sterki.)

Animal: Not examined.

Distribution: Lilycash Creek, Joliet, Ill. (J. H. Handwerk).

Geological distribution: Pleistocene?

Habitat: Living in soft mud with *P. compressum*, etc.

Remarks: "Probably it has been overlooked in materials from other places, owing to its resemblance to immature specimens of some forms of *P. compressum* Pr. When once known it will always be recognized. It also resembles some forms of *P. pauperculum* Sterki, in size and shape, but its comparatively coarse striation will distinguish it at once. *Pis. handwerki* is not a showy Pisidium, with striking features, but nevertheless a good species." (Sterki.)

161. **Pisidium kirklandi** Sterki. Unfigured.

Pisidium kirklandi STERKI, The Nautilus, Vol. XIII, p. 11, 1899.

"Mussel of medium size, somewhat oblique, well inflated when mature, very little so in the young, high, rather oval in outline; superior margin strongly, inferior moderately curved; posterior slightly truncated, passing into the superior by an obtuse, rounded angle, antero-superior slightly curved or almost straight, sloping toward the rounded anterior end; scutum well, scutellum slightly marked; beaks somewhat posterior, high and prominent in the mature, low in the young mussel, with stout ridges, highest at the posterior and slanting toward the anterior ends, slightly sinuous on the outer sides; surface with very coarse, rather regular striation, dull, rugulose, straw colored in young, slightly grayish in the adult with a light zone along the margin; shell rather thick, nacre almost glossy, appearing bluish in old specimens, muscle insertions distinct; hinge stout, hinge plate broad; cardinal teeth of moderate size, rather high up on the plate, the right one angular, its posterior plate thickened, with or without a groove; below it is a deep excavation; left cardinal teeth: the anterior rather stout but its edge acute, the posterior oblique, slightly curved; lateral teeth stout, the outer ones of the right valve quite small; ligament strong." (Sterki.)

Length, 4.00; height, 3.80; breadth, 2.70 mill.

Animal: Not examined.

Distribution: Michigan, Illinois and Ohio.

Geological distribution: Unknown.

Remarks: "*Pis. kirklandi* is related to *P. compressum* Pr., and more so to *fallax* St. From the former it is at once distinguished by the more rounded outlines of the adult specimens; the young are higher in the anterior part and the mussel is nearly square, while the young of *compressum* are more triangular; and in the latter the beaks are higher, the (young) mussel is of comparatively larger diameter. From *P. fallax* it differs by its large size, the coarse striation, the shape of the ridges and the grayish color." (Sterki.)

This species is known only from Berry Lake, in the southern region.

. . . . . .

Dr. Sterki reports that among fossils from the lower Loess at Freeport, Ill., he found *Pisidium virginicum*, *variabile*, *compressum*, *fallax*, *cruciatum*, *punctatum*, *walkeri* and (?) *abditum*. *Pisidium virginicum*, *P. abditum* and *P. compressum* have been dredged in Lake Superior at depths ranging from four to fourteen fathoms.

162. **Limnæa auricularia** Linné. Text fig. 138.

**Limnæa auricularia* LINNE, Syst. Nat., Ed. XII, p. 1249.

Shell: Roundly ovate, inflated, thin; color horny to pale gold; nucleus consisting of one and a half spermaceti-colored, smooth, rapidly increasing whorls; surface shining, lines of growth fine, wavy, crowded, with occasionally a heavy ridge representing a rest period; whorls four, convex, inflated, the last large and spreading; spire short, conic, very small compared with the body whorl; sutures deeply impressed, channeled in some specimens; aperture very large, ovate, occupying four-fifths of the length of the entire shell, rounded above and flaring in old specimens below; peristome thin, sharp; columella sigmoid with a plait across the middle, which is reflected over the umbilicus; umbilicus narrow, deep, nearly closed. The epidermis is sometimes marked by light and dark lines of color, alternating.

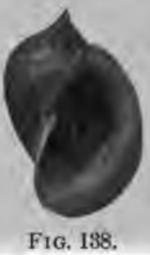

FIG. 138.

LIMNÆA AURICULARIA Linné. Natural size.

Length, 23.00;	breadth, 17.00;	aperture length, 18.00;	breadth,	11.00 mill.
" 20.00;	" 15.50;	" " 15.50;	"	9.50 "
" 18.00;	" 12.50;	" " 13.50;	"	8.50 "

Animal. Body flecked with small white spots on back of head and tentacles, but not on foot; mantle marked by many black, irregular spots which show through the shell; foot roundly elongated, 18 by 11 mill., head broad, auriculated; tentacles large, flat, long, triangular; heart pulsations slow and regular; thirty-four per minute. The animal is slow and deliberate in its movements.

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*No attempt has been made to include the synonymy of this species.

Jaw and radula: Not examined.

Genitalia: Not examined.

Distribution: European; greenhouse and lily-pond in Lincoln Park, Chicago.

Geological distribution: Pleistocene.

Habitat: Similar to that of the larger Limnæas.

Remarks: Some time ago Mr. Herbert E. Walter, Instructor in biology in the North Division High School, Chicago, brought to the writer several specimens of a Limnæa which was new to the fauna of the United States. Upon inquiry the locality was given as the propagating greenhouse in Lincoln Park. Several days later Miss Marie La Grange, a pupil in the North Division High School, found a number of the same species in a lily pond in the Park, the water of which was artificially heated to give the necessary warmth for certain tropical plants, the temperature being above 90° Fahr.

Comparison with the shells in the Academy's collection showed the species to be *Limnæa auricularia*, and an inquiry of the park gardener brought to light the fact that certain plants had been recently imported from Belgium. This information at once removed the mystery surrounding the sudden appearance of this shell in the Park, and shows how easy it is at the present time to transport a species from one continent to another, especially if it be a pulmonate. The shells of *auricularia* are about an inch in length, of a deep corneous color, and are rather thin. When alive, the mantle of the animal is seen through the shell to be made up of dark and light spots arranged irregularly. The animal appeared rather active, moving about the aquarium with a steady, gliding motion.

163. **Amnicola walkeri** Pilsbry.

Amnicola walkeri PILSBRY, The Nautilus, Vol. XII, p. 43, 1898.

Shell: "Thin, narrowly umbilicate, conic, shaped like *Lyogyrus brownii* Carpenter; slightly yellowish corneous; thin, smooth, with faint growth-lines. Whorls four, very convex, separated by deeply constricting sutures, the last whorl rounded below; apex obtuse. Aperture oblique, rather small, mainly basal, a little longer than wide, but nearly circular, the inner margin a trifle straightened above; peristome continuous, in contact with the preceding whorl for an extremely short distance above. Operculum Amnicoloid."

Alt. 3, diam. 2; length of aperture, 1¼; width 1⅛ mm.
" 2⅓, " 2⅛; " " 1.08; " 1 " Pilsbry.

Animal: Not examined.

Radula: Amnicoloid. (Pilsbry.)

Distribution: "Lake Michigan at High Island Harbor, Beaver Island, at 19 meters depth; Reed's Lake, Grand Rapids, Mich.; River Rogue, Wayne Co., Mich.; the types from the first locality mentioned." (Pilsbry.) Joliet, Ill. (J. H. Ferriss.)

Geological distribution: Pleistocene.

Habitat: Similar to other Amnicola.

Remarks: This, one of the smallest of Amnicolæ, has recently been found at Joliet by Mr. J. H. Ferriss. It will be easily known by its small size and peculiar shape.

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Synonyms are printed in *italics;* genera, subgenera, families, etc., in SMALL CAPITALS; the page number indicating reference to a diagnosis is in *italics.*

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  - *hippopæus*, 80.
  - *inflatus*, 103.
  - *latecostatus*, 82.
  - *leprosus*, 101.
  - *lunulatus*, 83.
  - luteolus, 30, 33, 36.
  - *mortoni*, 86.
  - *novieboraci*, 105.
  - *occidens*, 94.
  - *pernodosus*, 86.
  - *pilsbryi*, 82, 83.
  - *prælongus*, 101.
  - *prasinus*, 86.
  - *quadratus*, 83.
  - *rariplicata*, 80.
  - *riddellii*, 76.
  - *sageri*, 101.
  - *satur*, 94.
  - *schoolcraftensis*, 86.
  - *schoolcraftii*, 86, 88.
  - *siliquoideus*, 103.
  - *subovatus*, 94.
  - *teres*, 100.
  - *truncatus*, 92.
  - *upsoni*, 108.
  - *zigzag*, 91.
- UNIONIDÆ, *47*.
- Utricularia vulgaris, 299.

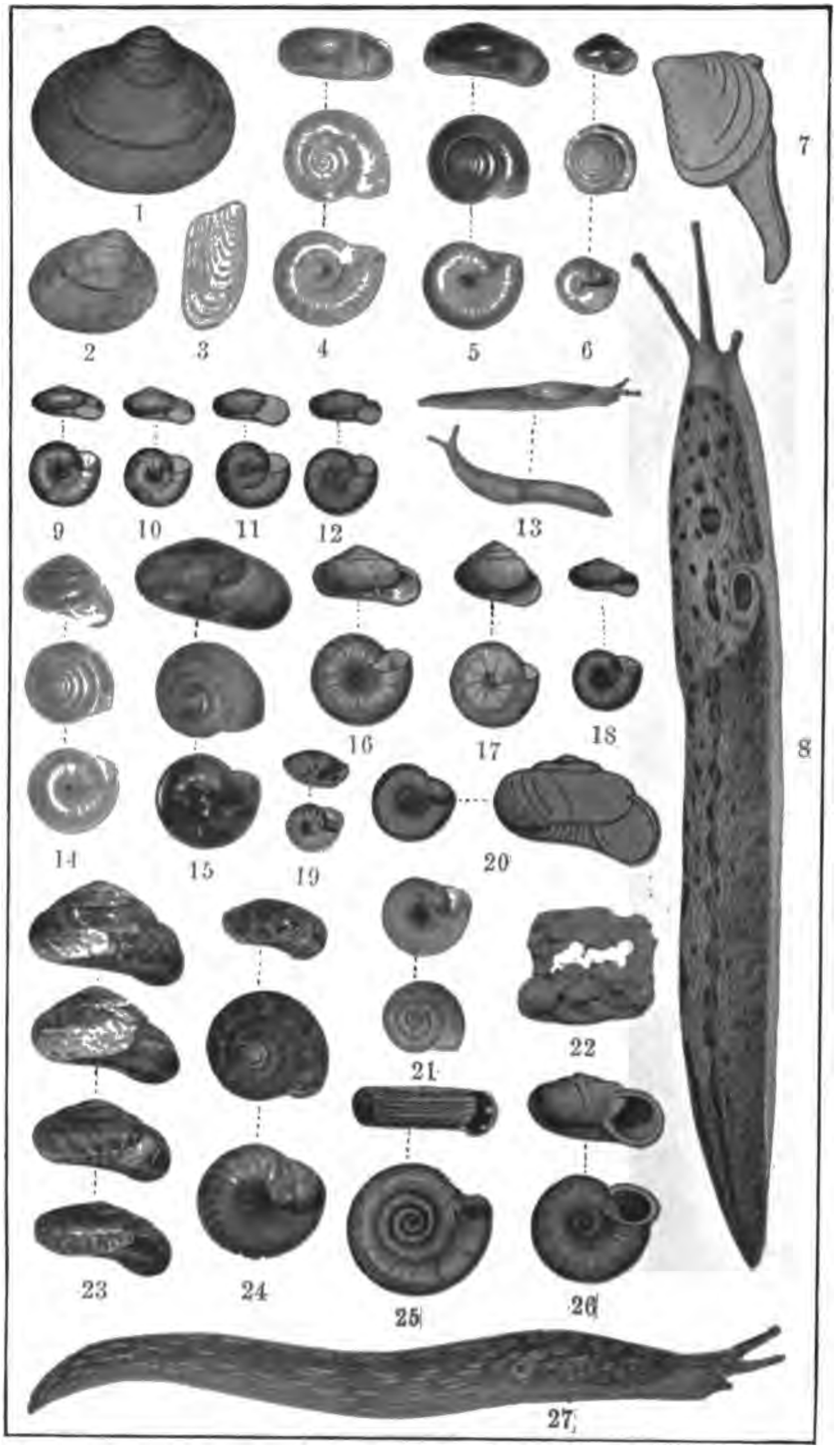
- VALLONIA, *248*.
- Vallonia *americana*, 252.
  - amurensis, 251.
  - costata, 251, 252, 253.
  - enniensis, 249.
  - helvetica, 251.
  - hispanica, 249.
  - montana, 251.
  - parvula, *252*.

EXPLANATION OF PLATE XXVIII.

Figure 1. Pisidium abditum Hald. Prime, Monog., fig. 72. Enlarged.
" 2. Pisidium virginicum Bourg. Prime, Monog., fig. 61. Enlarged.
" 3. Limax maximus Linné. Shell. Tryon, Mon. Terr. Moll., pl. xvi, fig. 2.
" 4. Circinaria concava Say.
" 5. Vitrea draparnaldi Beck.
" 6. Gastrodonta demissa Binney.
" 7. Pisidium compressum Prime. Monog., fig. 67. Enlarged.
" 8. Limax maximus Linné. Tryon, Mon. Terr. Moll., pl. xvi, fig. 2.
" 9. Zonitoides arboreus Say. Binney, Man. Am. Land Sh., fig. 13. Enlarged.
" 10. Vitrea hammonis Strom. Binney, Man. Am. Land Sh., fig. 21. Enlarged.
" 11. Vitrea indentata Say. Binney, Man. Am. Land Sh., fig. 15. Enlarged.
" 12. Zonitoides minusculus Binney. Binney, Man. Am. Land Sh., fig. 18. Enlarged.
" 13. Agriolimax campestris Binney. Tryon, Mon. Terr. Moll., pl. xvii, figs. 12, 13.
" 14. Gastrodonta ligera Say.
" 15. Omphalina fuliginosa Griff.
" 16 Zonitoides nitidus Müller. Binney, Mon. Am. Land Sh., fig. 12. Enlarged.
" 17. Euconulus fulvus Drap. Binney, Mon. Am. Land Sh., fig. 26. Enlarged.
" 18. Pyramidula striatella Anth. Binney, Mon. Am. Land Sh., fig. 28. Enlarged.
" 19. Pyramidula alternata Say. Juvenile.
" 20. Punctum pygmæum Drap. Binn., Man. Am. Land Sh., fig. 31. Enlarged.
" 21. Pyramidula alternata Say. Albino.
" 22. Pyramidula alternata Say. Eggs.
" 23. Pyramidula alternata Say. Variation in height of spire.
" 24. Pyramidula alternata Say.
" 25. Pyramidula lineata Say. Binney, Man. Am. Land Sh., fig. 37. Enlarged.
" 26. Vallonia pulchella Müller. Binney, Man. Am. Land Sh., fig. 39. Enlarged.
" 27. Limax flavus Linné. Tryon, Mon. Terr. Moll., pl. xvi, fig. 3.

All natural diameter, except where otherwise mentioned.

PLATE XXVIII



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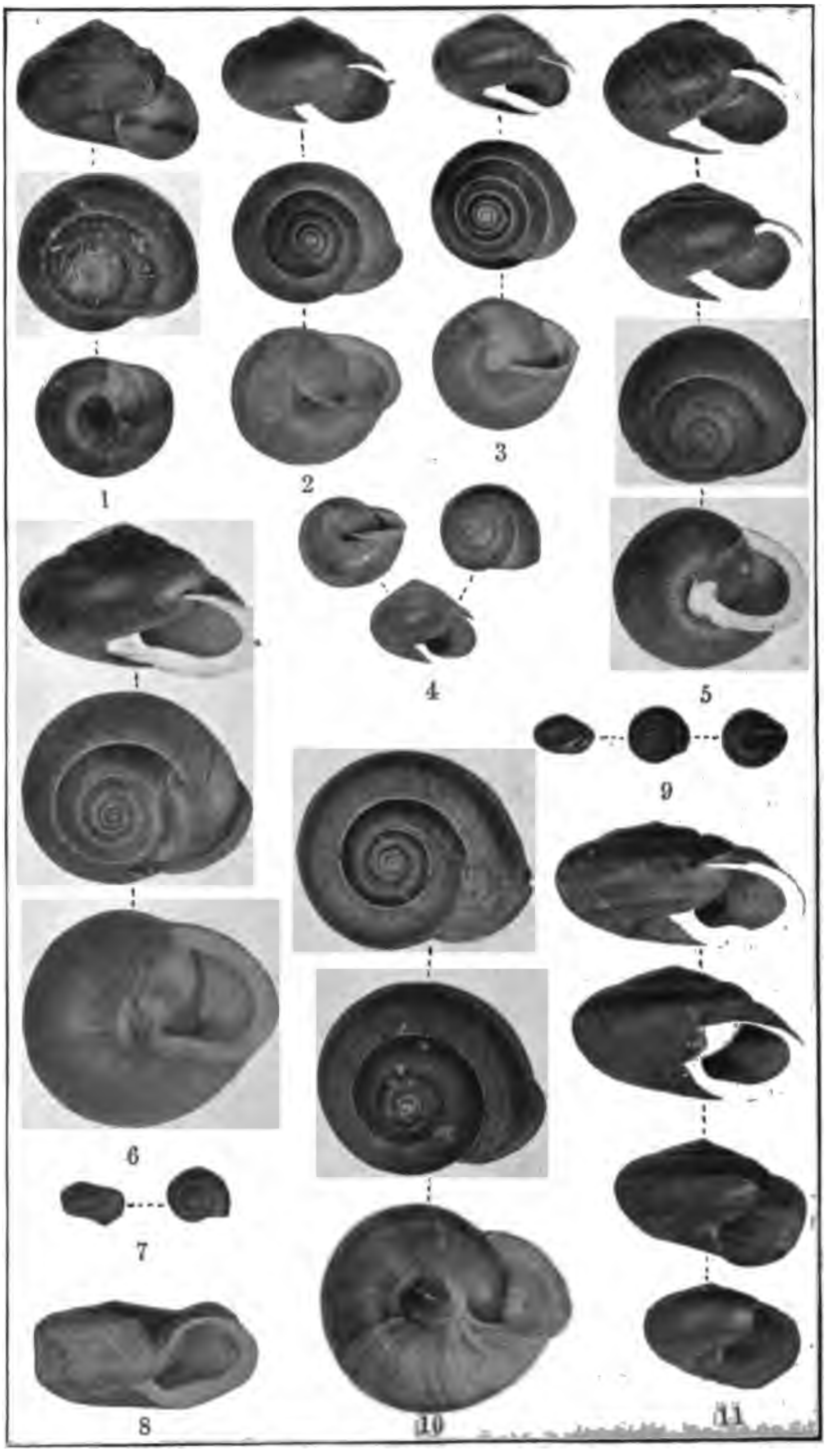
EXPLANATION OF PLATE XXIX.

Figure 1. Pyramidula solitaria Say.
" 2. Polygyra thyroides Say.
" 3. Polygyra pennsylvanica Green.
" 4. Polygyra clausa Say.
" 5. Polygyra exoleta Binney.
" 6. Polygyra albolabris Say.
" 7. Polygyra thyroides Say. Juvenile.
" 8. Polygyra profunda Say. Deformed.
" 9. Polygyra hirsuta Say.
" 10. Polygyra profunda Say.
" 11. Polygyra profunda Say. Juvenile and adult.

All natural diameter.

PLATE XXIX.



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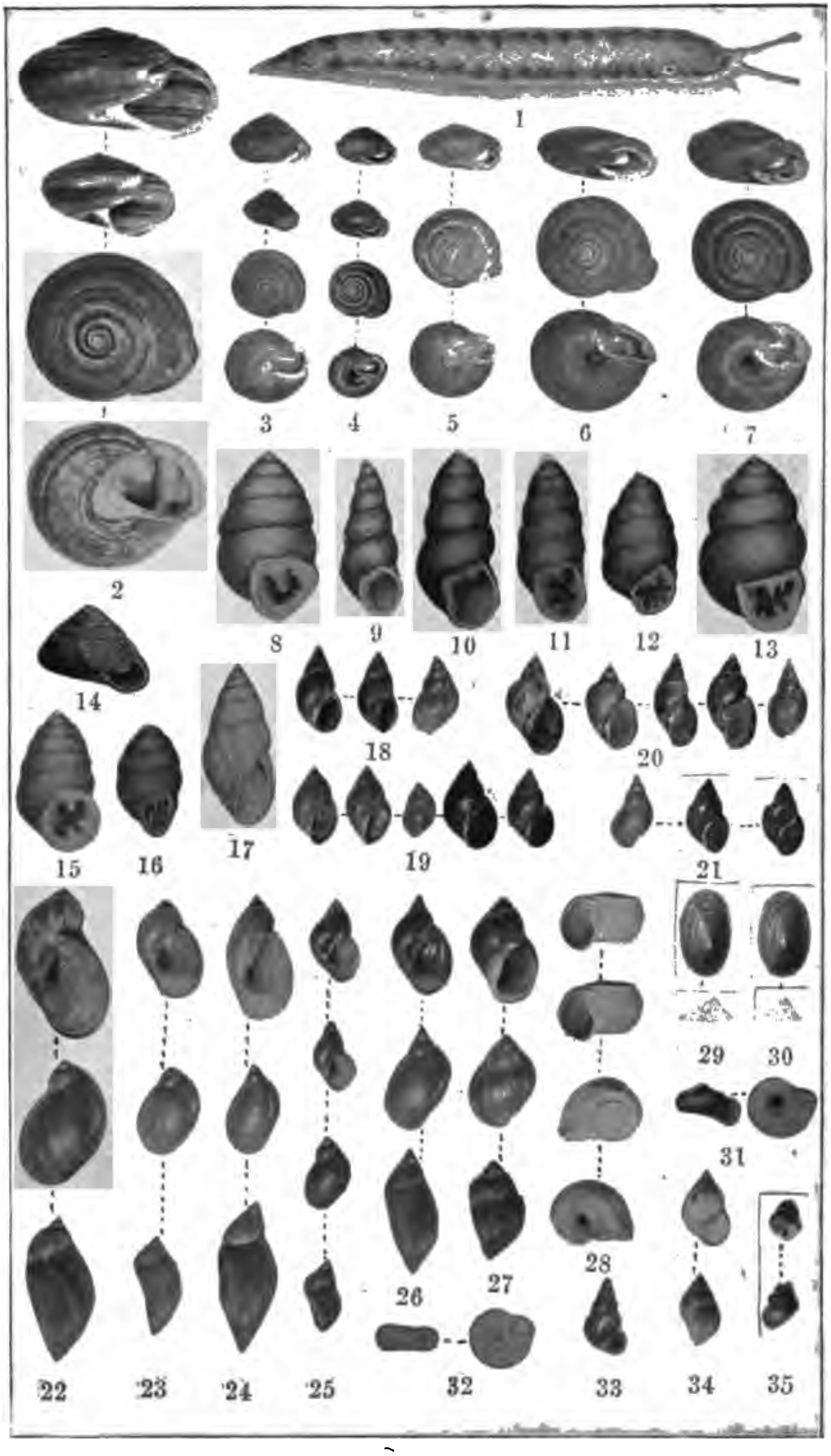
EXPLANATION OF PLATE XXX.

Figure 1. Philomycus carolinensis Binney. Tryon, Mon. Terr. Moll., pl. xvi, fig. 6.
" 2. Polygyra multilineata Say.
" 3. Polygyra monodon fraterna Say.
" 4. Polygyra monodon Rackett.
" 5. Polygyra inflecta Say.
" 6. Polygyra tridentata Say
" 7. Polygyra fraudulenta Pilsbry.
" 8. Bifidaria contracta Say. Tryon, Mon. Terr. Moll. pl. xv, fig. 16. Enlarged.
" 9. Pupoides marginatus Say. Tryon, Mon. Terr. Moll., pl. xv, fig. 10. Enlarged.
" 10. Bifidaria corticaria Say. Tryon, Mon. Terr. Moll., pl. xv, fig. 18. Enlarged.
" 11. Bifidaria procera Gould. Tryon, Mon. Terr. Moll., pl. xv, fig. 17. Enlarged.
" 12. Bifidaria pentodon Say. Tryon, Mon. Terr. Moll., pl. xv, fig. 5. Enlarged.
" 13. Vertigo ovata Say. Tryon, Mon. Terr. Moll., pl. xv, fig. 22. Enlarged.
" 14. Strobilops labyrinthica Say. Binney, Man. Am. Land Sh., fig. 150. Enlarged.
" 15. Bifidaria armifera Say. Tryon, Mon., Terr. Moll., pl. xv, fig. 15. Enlarged.
" 16. Vertigo milium Gould. Tryon, Mon. Terr. Moll., pl. xv, fig. 21. Enlarged.
" 17. Cochlicopa lubrica Müller. Tryon, Mon. Terr. Moll., pl. xiv, fig. 14. Enlarged.
" 18. Limnæa caperata Say.
" 19. Limnæa caperata umbilicata Adams.
" 20. Limnæa desidiosa Say.
" 21. Limnæa humilis Say. Haldeman, Mon., pl. xiii, figs. 4, 5. A little enlarged.
" 22. Succinea ovalis Say.
" 23. Succinea ovalis near totteniana Lea.
" 24. Succinea retusa Lea.
" 25. Succinea avara Say.
" 26. Limnæa columella Say.
" 27. Limnæa catascopium pinguis Say.
" 28. Planorbis truncatus Miles.
" 29. Ancylus rivularis Say. Haldeman, Mon., pl. i, fig. 1. Enlarged.
" 30. Ancylus tardus Say. Haldeman, Mon., pl. i, fig. 3. Enlarged. Outline figures are lateral views.
" 31. Valvata sincera Say. Haldeman, Mon., pl. i, figs. 7, 8.
" 32. Segmentina armigera Say. Haldeman, Mon., pl. iv, figs. 12, 13.
" 33. Pomatiopsis lapidaria Say. Haldeman, Mon., pl. i, fig. 10.
" 34. Bythinia tentaculata Linné.
" 35. Amnicola limosa Say.

All figures natural diameter except where otherwise mentioned.

PLATE XXX.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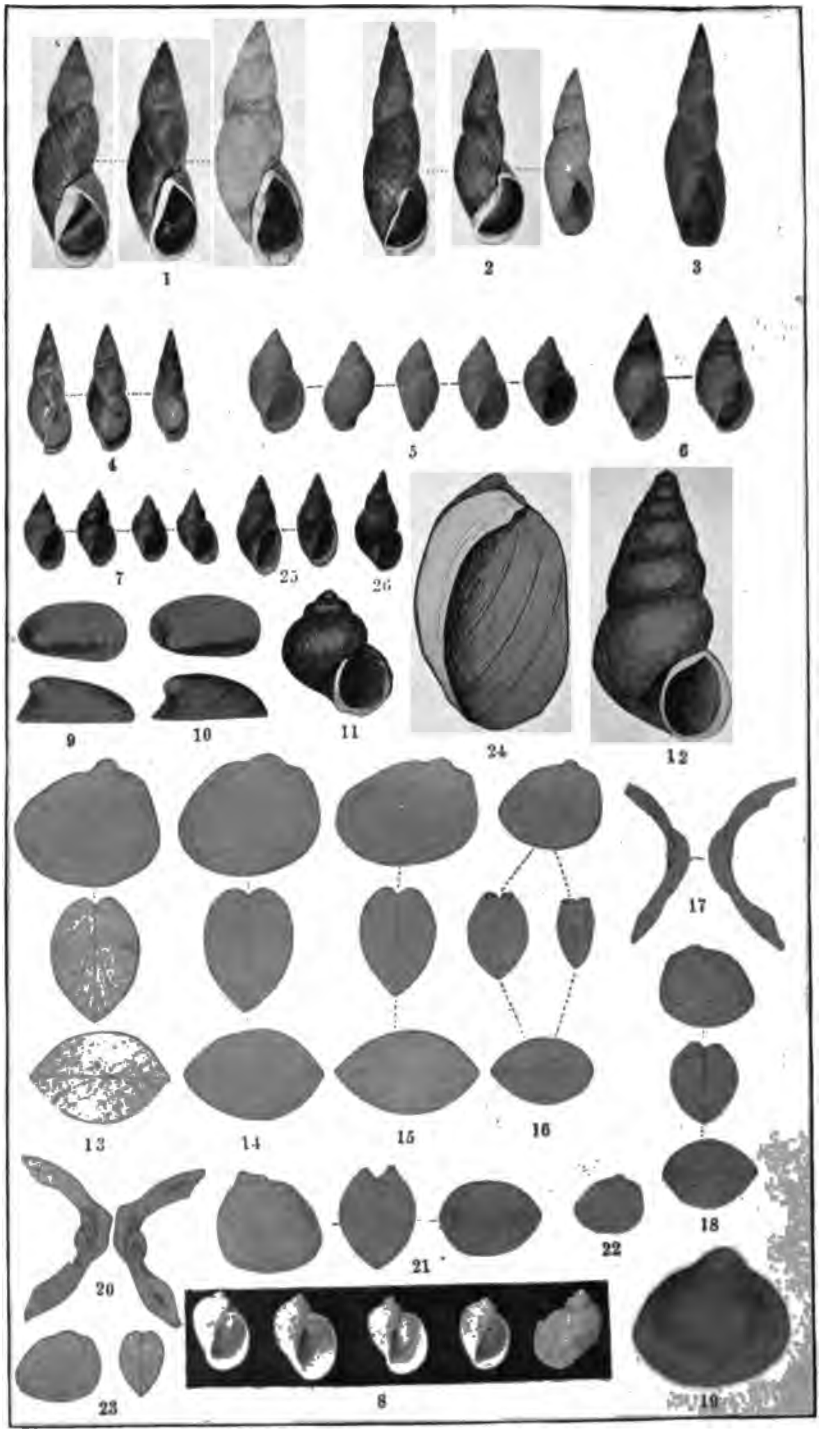
EXPLANATION OF PLATE XXXI.

Figure 1. Limnæa reflexa Say. Near walkeri Baker.
" 2. Limnæa reflexa walkeri Baker. Only the center figure is typical.
" 3. Limnæa reflexa exilis Lea. Variety.
" 4. Limnæa reflexa kirtlandiana Lea.
" 5. Limnæa catascopium Say.
" 6. Limnæa palustris nutalliana Lea.
" 7. Limnæa desidiosa Say. Variety with rounded whorls.
" 8. Limnæa woodruffi Baker.
" 9. Ancylus shimekii Pilsbry. Not so oblique as the type. Enlarged.
" 10. Ancylus shimekii Pilsbry. Type form. Enlarged.
" 11. Amnicola limosa parva Lea. Enlarged.
" 12. Pomatiopsis lapidaria Say. Enlarged.
" 13. Pisidium politum Sterki. Lateral, posterior, and dorsal views.
" 14. Pisidium scutellatum Sterki. Lateral, posterior, and dorsal views.
" 15. Pisidium walkeri Sterki. Lateral, posterior, and dorsal views.
" 16. Pisidium fallax Sterki. Lateral, posterior, and dorsal views.
" 17. Pisidium punctatum Sterki. Hinge. (The Nautilus, Vol. VIII, pl. ii.) Enlarged.
" 18. Pisidium punctatum Sterki. The Nautilus, Vol. VIII, pl ii.) Enlarged.
" 19. Pisidium variabile Prime. Mon. Am. Corbic., fig. 69. Enlarged.
" 20. Pisidium cruciatum Sterki. Hinge. The Nautilus, Vol. VIII, pl. ii. Enlarged.
" 21. Pisidium cruciatum Sterki. The Nautilus, Vol. VIII, pl. ii. Enlarged.
" 22. Pisidium punctatum Sterki. Young specimen.
" 23. Pisidium splendidulum Sterki. Lateral and posterior views.
" 24. Testacella haliotoidea Fer. Shell, enlarged.
" 25. Limnæa palustris michiganensis Walker.
" 26. Limnæa ferrissi Baker.

Figures 13 16 and 22-23 are outline drawings by Dr. Sterki, x10. All others, except where otherwise designated, are natural diameter.

PLATE XXXI



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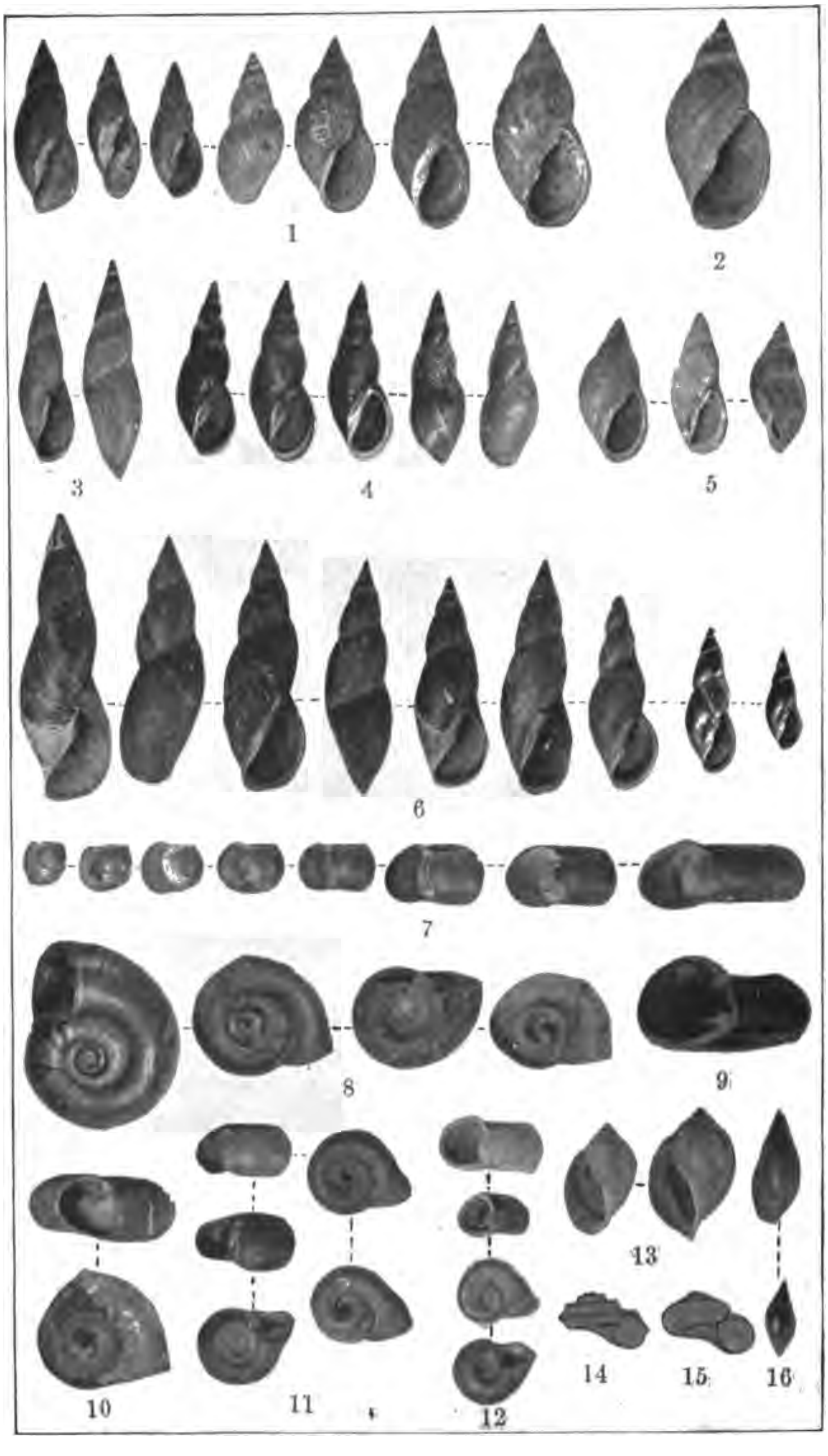
EXPLANATION OF PLATE XXXII.

Figure 1. LIMNÆA PALUSTRIS Müller.
" 2. LIMNÆA PALUSTRIS EXPANSA Lea. (SUFFLATUS Calkins).
" 3. LIMNÆA REFLEXA EXILIS Lea.
" 4. LIMNÆA REFLEXA JOLIETENSIS Baker.
" 5. LIMNÆA PALUSTRIS MICHIGANENSIS Walker. Large variety.
" 6. LIMNÆA REFLEXA Say.
" 7. PLANORBIS TRIVOLVIS Say. Age variation.
" 8. PLANORBIS TRIVOLVIS Say.
" 9. PLANORBIS TRIVOLVIS Say.
" 10. PLANORBIS TRIVOLVIS Say. (DISTORTUS Calkins).
" 11. PLANORBIS CAMPANULATUS Say.
" 12. PLANORBIS BICARINATUS Say.
" 13. PHYSA SAYII Tappan. Short spired variety.
" 14. VALVATA TRICARINATA Say. Enlarged.
" 15. VALVATA SINCERA Say. Enlarged.
" 16. APLEXA HYPNORUM Linné.

All figures natural diameter except where otherwise mentioned.

PLATE XXXII.



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EXPLANATION OF PLATE XXXIII.

A, B, C. Animal of *Limnæa emarginata* Say, var. *mighels*, Binney. A, from above; B, from below; C, from the right side, showing extended velum.

D. Genitalia (principally female).
A, atrium or vestibule of vagina; AL, albuminiparous gland; O, ovotestis; OD, ovisperm duct; PD, duct of prostate gland; PR, prostate; S, spermatheca or receptaculum seminis; SD, duct of spermatheca; V, vagina; VM, retractor muscles of vagina; U, uterus.

E. Male organs.
CG, cerebral ganglion; CM, columella muscle; F, vas deferens; P, penis; PG, pleural ganglion; PN, nerve to penis; PS, penis sac; PSM, penis sac protractor muscles; PSN, penis sac nerve; RM, retractor muscle of penis; VD, penis retractor muscle; G, visceral ganglion; VN, nerve to vagina.

F. Portion of ovotestis, showing blood vessels (x 519).

G. Cells from the albuminiparous gland (x 519).

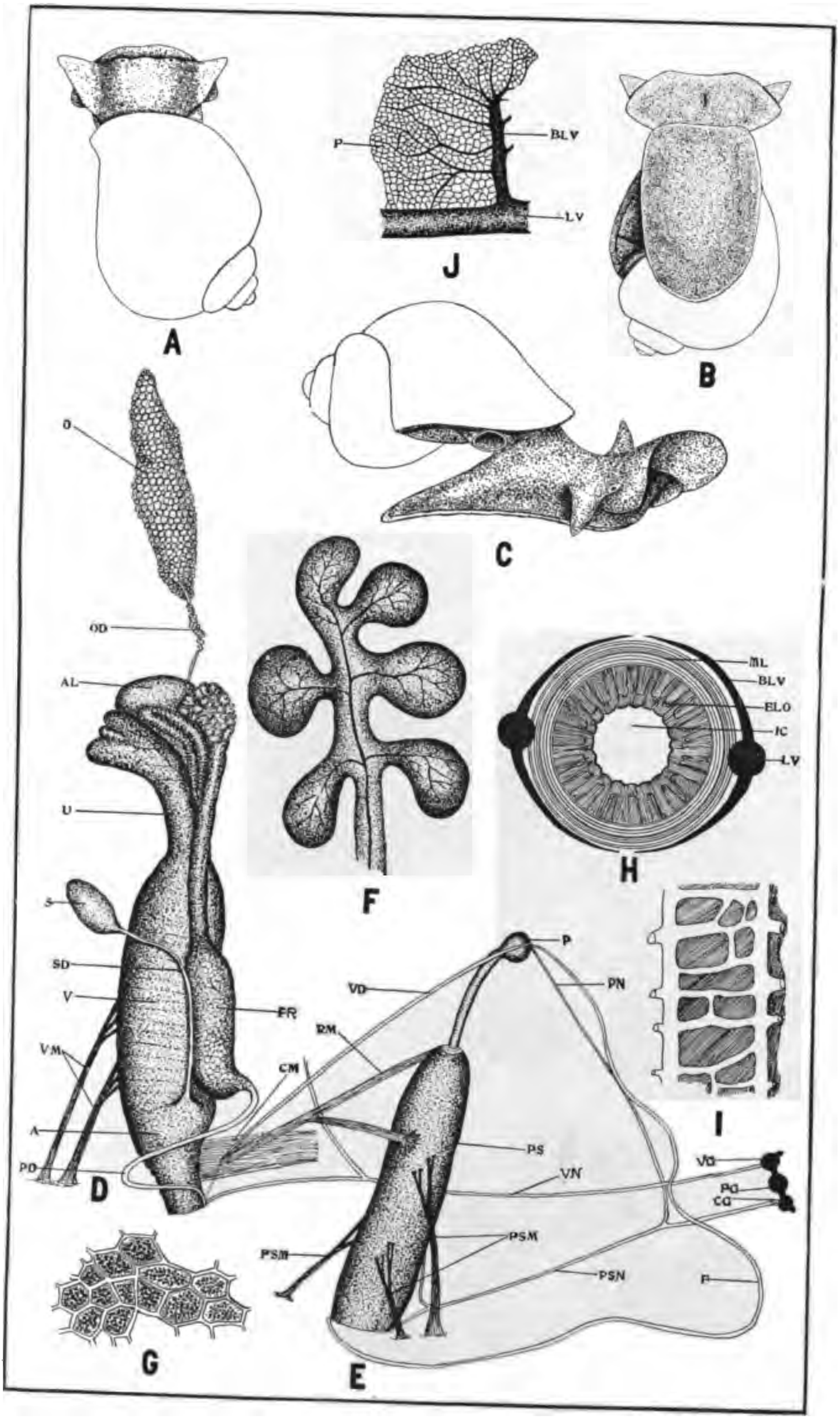
H. Diagrammatic section of intestine; BLV, branch of lateral blood vessel; ELO, epithelial layer of œsophagus; IC, intestinal cavity; LV, lateral blood vessel; ML, muscular layer of œsophagus.

I. Portion of lung, showing two main vessels and several connective vessels (x 519).

J. Portion of lateral blood vessel with one branch with its connective plexus (x 519).

(Bull. Chi. Acad. Sci., Vol. II, No. 3, pl. iii.)

PLATE XXXIII.



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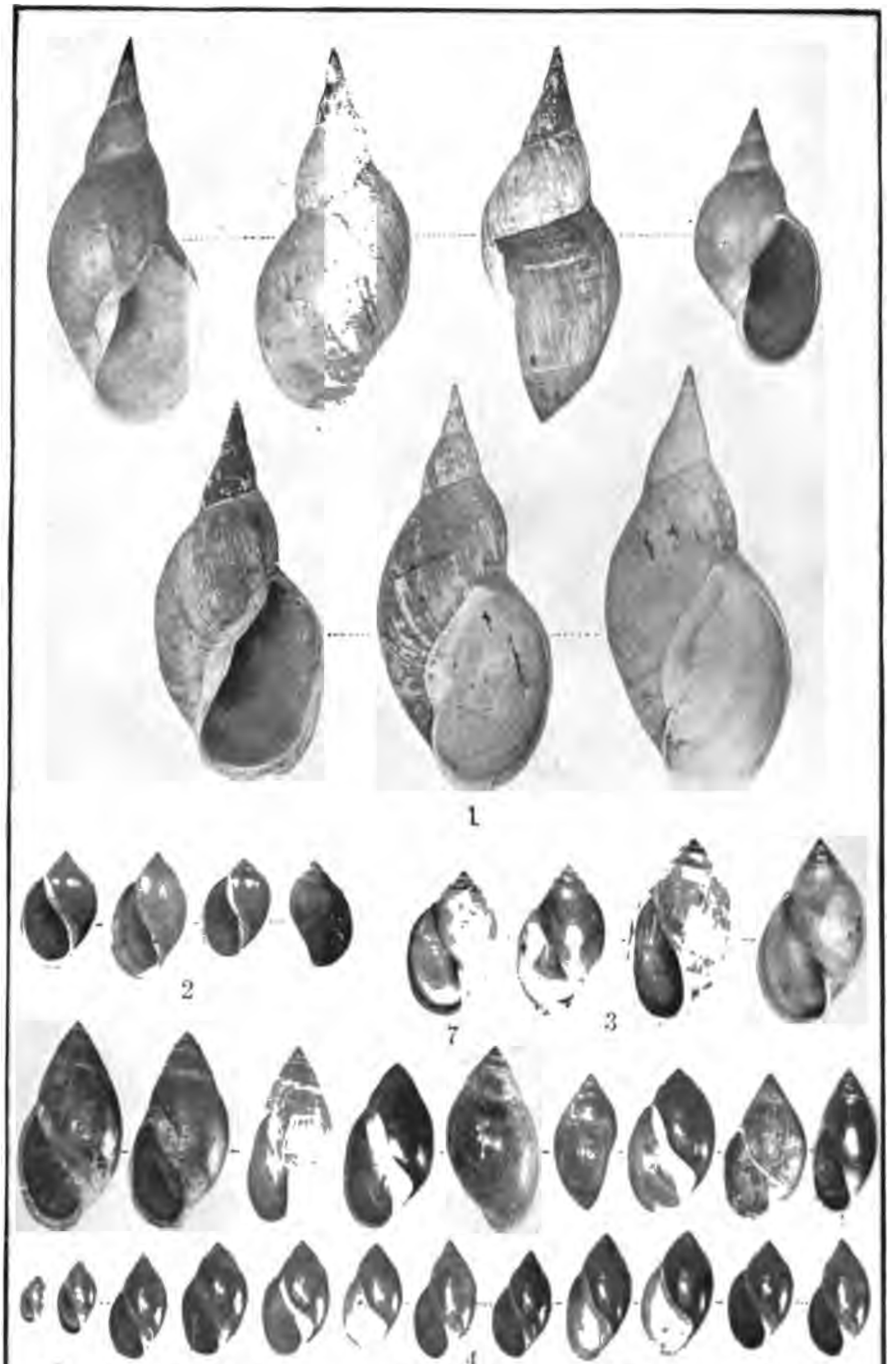
EXPLANATION OF PLATE XXXIV.

Figure 1. LIMNÆA STAGNALIS APPRESSA Say.
" 2. PHYSA HETEROSTROPHA Say.
" 3. PHYSA SAYII Tappan.
" 4. PHYSA GYRINA Say.
" 5. PHYSA GYRINA ELLIPTICA Lea.
" 6. PHYSA INTEGRA Haldeman.
" 7. PHYSA SAYII Tappan. Short spired variety.

All natural diameter.

PLATE XXXIV.

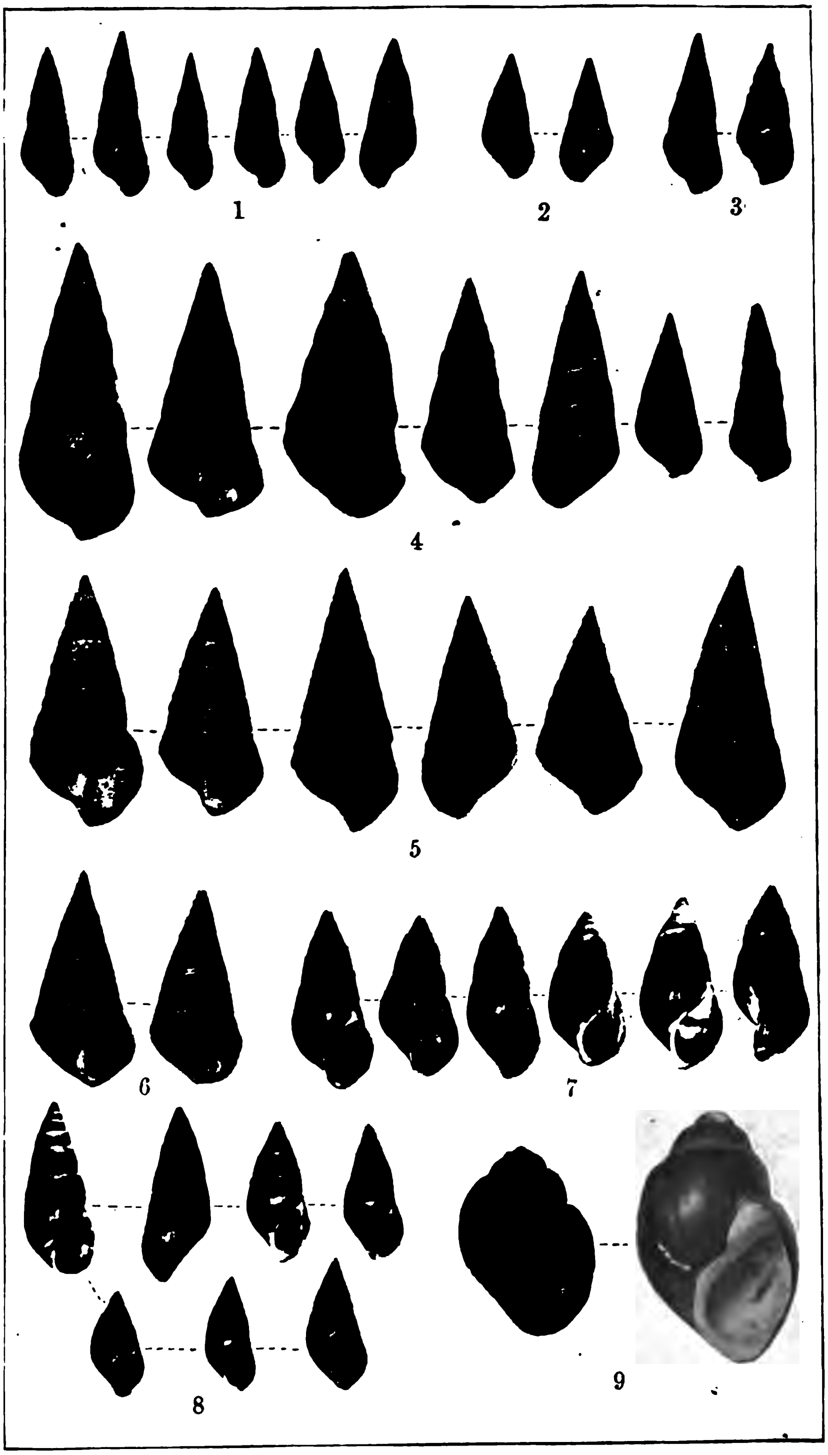


EXPLANATION OF PLATE XXXV.

Figure 1. Pleurocera subulare Lea. Males.
" 2. Pleurocera subulare Lea. Females.
" 3. Pleurocera subulare intensum Anthony.
" 4. Pleurocera elevatum Say.
" 5. Pleurocera elevatum lewisii Lea.
" 6. Pleurocera elevatum lewisii Lea.
" 7. Goniobasis livescens Menke.
" 8. Goniobasis livescens depygis Say.
" 9. Campeloma ponderosum Say.

All natural diameter.

PLATE XXXV.



EXPLANATION OF PLATE XXXVI.

Figure 1. Vivipara contectoides Binney.
" 2. Vivipara contectoides Binney. Operculum.
" 3. Vivipara contectoides Binney. Without bands.
" 4. Campeloma rufum Haldeman. Female.
" 5. Campeloma decisum Say. Females.
" 6. Campeloma rufum Haldeman. Males.
" 7. Campeloma decisum Say. Males.
" 8. Campeloma subsolidum Anthony. Reversed.
" 9. Campeloma subsolidum Anthony. Female.
" 10. Campeloma subsolidum Anthony. Male (milesi Lea).
" 11. Campeloma subsolidum Anthony. Operculum.
" 12. Campeloma subsolidum Anthony. Males.

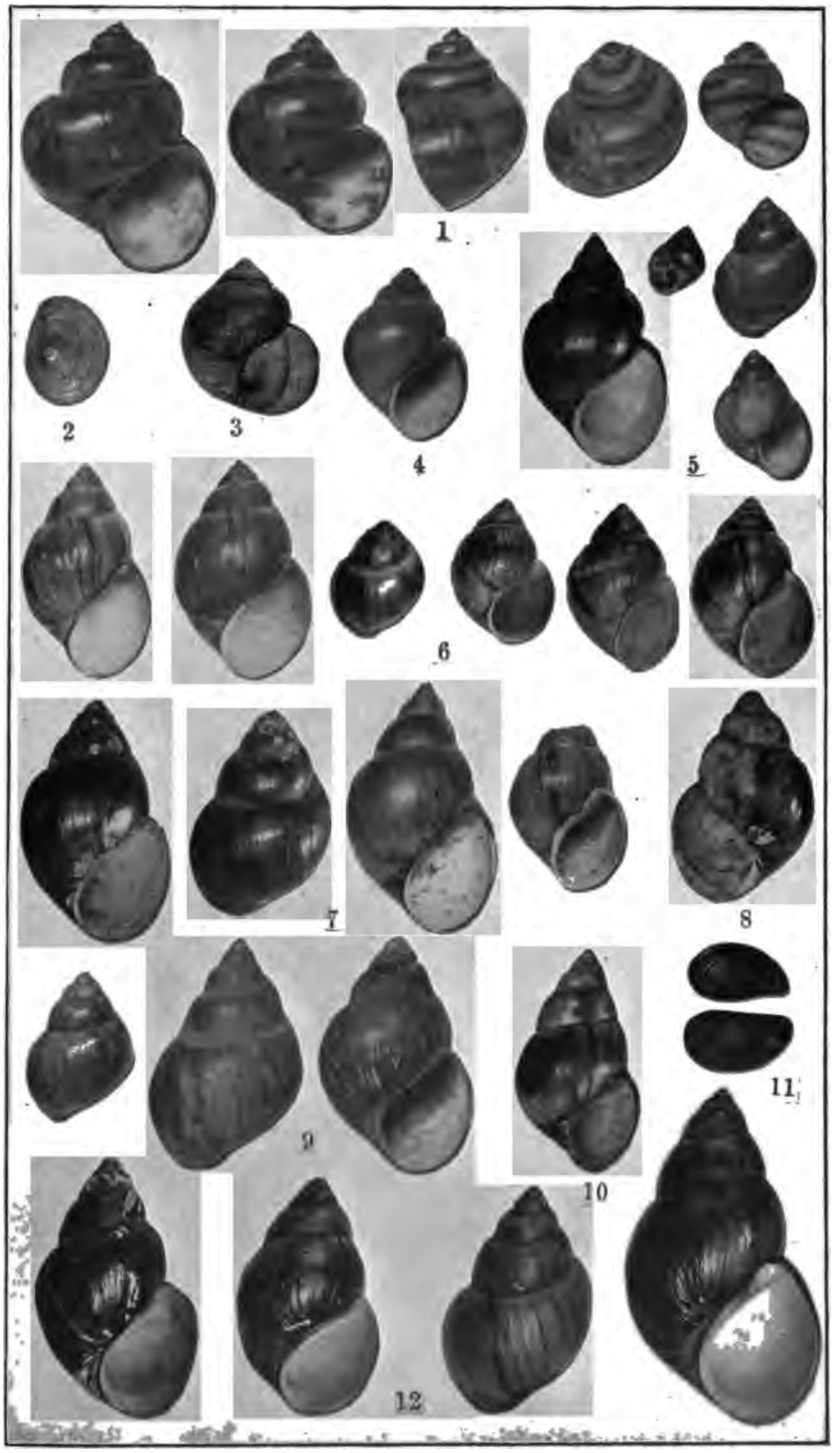
All natural diameter.

EXPLANATION OF PLATE XXXVI.

Figure 1. VIVIPARA CONTECTOIDES Binney.
" 2. VIVIPARA CONTECTOIDES Binney. Operculum.
" 3. VIVIPARA CONTECTOIDES Binney. Without bands.
" 4. CAMPELOMA RUFUM Haldeman. Female.
" 5. CAMPELOMA DECISUM Say. Females.
" 6. CAMPELOMA RUFUM Haldeman. Males.
" 7. CAMPELOMA DECISUM Say. Males.
" 8. CAMPELOMA SUBSOLIDUM Anthony. Reversed.
" 9. CAMPELOMA SUBSOLIDUM Anthony. Female.
" 10. CAMPELOMA SUBSOLIDUM Anthony. Male (MILESI Lea).
" 11. CAMPELOMA SUBSOLIDUM Anthony. Operculum.
" 12. CAMPELOMA SUBSOLIDUM Anthony. Males.

All natural diameter.

PLATE XXXVI.



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THE CHICAGO ACADEMY OF SCIENCES

The Mollusca of the Chicago Area

THE GASTROPODA

BY

FRANK COLLINS BAKER
CURATOR OF THE CHICAGO ACADEMY OF SCIENCES

BULLETIN No. III.

PART II.

OF

THE NATURAL HISTORY SURVEY

ISSUED APRIL 25, 1902.